

THURSDAY, JUNE 19, 1879

## ELECTRIC LIGHTING

*L'Éclairage Électrique.* Par le Comte Th. du Moncel. (Paris: Hachette and Co., 1879.)

*Electric Lighting and its Practical Application.* By J. N. Shoolbred, M.Inst.C.E. (London: Hardwicke and Bogue, 1879.)

*The Electric Light in its Practical Application.* By Paget Higgs, LL.D. (London: Spon, 1879.)

THE little work, which now appears amongst the numerous volumes of the "Bibliothèque des Merveilles," though containing much more of real information than many of the sketchy works of that popular series, is somewhat disappointing. Like the other writings which the Comte du Moncel has given to the world, it displays a remarkable amount of industrious compilation, but the arrangement of the matter collected is somewhat cumbersome. A far superior book to his recent work on the Telephone, it is nevertheless marred by the same occasional confusion of thought exhibited in that work. It contains, however, in a small compass, a good deal of useful information, and enough serious reading to make it pass as a scientific book.

After fifty pages of generalities the author settles down to discuss the different systems of magneto-electric machines and their comparative efficiency. Next comes a chapter on "*organes excitateurs de la lumière électrique*," which we discover to include carbons of various manufacturers, and materials for lighting by incandescence. Then follow three chapters on regulators, incandescent lamps, and electric candles; after that a *résumé* of the cost of electric lighting; and finally a capital chapter on its numerous applications.

With regard to magneto-electric and dynamo-electric machines, great pains have evidently been taken to give a fair account of most of the systems of importance. In this respect the present work contrasts very favourably with that of M. Fontaine, in which such a disproportionate amount of space is allotted to the Gramme machines. Beginning with the early machines of Nollet, Wilde, Holmes, and Ladd, the successive inventions of Gramme, Siemens, de Meritens, Wallace, Brush, and Lontin are carefully explained, excellent woodcuts of most of these being appended. The "distributing" machines of Lontin, Gramme, and Jablockhoff are also noticed. We take exception to the statement that the Wallace-Farmer machine is merely an enlarged copy of those of Wilde and Lontin. It differs essentially from the former, and in point of date was earlier in the field than the latter. If there be one machine more than another that it does resemble, it is the machine of M. Alfred Niaudet, of which M. du Moncel makes no mention. On the very important question of the relative efficiency of the various systems, M. du Moncel has nothing to say that is new, but simply reproduces the tabular results published by the authorities of Trinity House and by the Committee of the Franklin Institute. His treatment of the question of the cost of electric lighting is even less satisfactory, the figures obtained as the result of the most recent experiments

on a large scale in Paris and London being entirely omitted.

In treating of Regulators the author employs a classification deserving of attention. They are divided into six categories, viz.: (1) Regulators founded on the attraction of solenoids, as those of Archereau, Gaiffe, Jaspar, and Brush; (2) those depending on movements worked by electromagnets, as the lamps of Duboscq, Foucault, Serrin, Siemens, and Rapiéff; (3) those with large circular carbons, as the regulators of Wright and Reynier; (4) those depending on hydrostatic reaction, as Way's mercurial lamp; (5) those depending on the reaction of the current itself, producing mutual repulsion between the carbon poles; and (6), lastly, those with fixed carbons, such as the electric candle of Jablockhoff. Lamps on the principle of incandescence so-called are treated of under a different head. The plate-lamp devised by Wallace is not mentioned. The following account of the process of manufacture of the Jablockhoff candles is new, and will be read with interest:—

"The manufacture of these candles carried on on a large scale at the Avenue de Villiers, where six or eight thousand a day are made, is really very interesting, especially the manner in which the insulating portions are fashioned. Upon a marble table slightly oiled is spread, by means of a moulding instrument made of a toothed strip of zinc fixed so as to slide in a suitable frame, a thin layer of plaster of Paris mingled with sulphate of baryta, and mixed so as not to set rapidly. This plaster is placed in front of the moulding instrument, which is then moved over the marble slab in such a way as to form grooves and ridges about two metres long. After the moulding tool has been passed backwards and forwards several times, a fresh quantity of plaster is placed in front of the instrument, thus increasing the thickness of the ridges; and at the end of five or six operations of this kind the ridges have exactly the thickness of the teeth of the moulding-tool, or that required for the insulator. The sides of these insulating strips are naturally made slightly concave to receive the carbons, which are cylindrical."

An account of the condensers employed by M. Jablockhoff in conjunction with the alternate-current generators that feed a series of candles, will also be found of some interest. M. du Moncel states that, without these condensers, the candle which has the least resistance of the four on one circuit absorbs so much of the current, that the other three are put out.

We have noticed, in perusing the work, a number of minor blemishes, which, should the book reach a second edition, might with advantage be removed. Thus we are told on p. 13, that Humphry-Davy (*sic*), in 1813, made the first experiments on the production of the voltaic arc, and that this discovery was "completed" by Foucault by the substitution of gas carbon for wood charcoal. If we remember rightly, Sir Humphry Davy's experiment in the Royal Institution, as recounted in the *Philosophical Transactions* for 1809, were made in 1808. Foucault's suggestion came in 1844.

What are we to understand by the following statement on p. 6?—"The *tension* of a current, which is often nowadays confounded (these italics are ours) with the *potential*, is the property of the electric fluid which gives in some sort the impulse of the electric movement . . ." This statement may be put by the side of another on p. 15, that it is possible "to augment the intensity of a gene-

erator at the expense of its tension, by condensing the charges."

Passing on to details concerning the light itself, we are told that the heating of the positive carbon to a higher temperature than the negative (an effect which, by the way, depends also upon the diameters of the two carbons) by the battery current does not take place with currents of high tension produced by induction machines. The author makes Professors Ayrtton and Perry responsible for the statement that the resistance of the arc is 255 ohms.

Again, on p. 25 we read that the *Bunsen's* cell was discovered in 1839 by *Grove*! And, on p. 34, that to ascertain the resistance of the circuit a rheostat is employed. We had hitherto imagined Prof. Bunsen's battery to be a somewhat later device than that of Sir William Grove, dating from 1842 or 1843, and that for all practical purposes the unreliable rheostat had long been superseded by reliable resistance-coils. We rub our eyes mentally over these little matters.

In one of the appendices some excellent remarks of Mr. W. H. Preece are transcribed entire. In another a brief account of Mr. Edison's patent is copied from the *Standard*, with the following comment:—"This patent, practicable or not, exhibits the usual ingenuity of Mr. Edison, says the *Standard*; for our part we cannot share this opinion, and can see nothing new in the patent. It is a crude idea which does not seem to us likely to lead to any important results."

There is little doubt that to a large class of readers an English translation of this work will be acceptable. It will, however, require careful revision by a competent editor, especially in those passages—numerous to an almost irritating degree—where the reader is referred to the previous works of the author. If this be done the book will fill a useful place at the present time, when so much ignorance prevails as to the nature of the electric light.

Mr. Shoolbred's "Electric Lighting" is an expansion of the papers read by him before the Society of Arts and elsewhere, and professedly deals chiefly with the question from the point of view of practical application. Hence we have in this volume not only the well-known results of experiments on the cost of the light in tabulated form, but also paragraphs on such outlying subjects as photometers, gas-engines, and water-motors. All the principal machines and lamps are briefly described, and many of them figured on lithographed plates. Under the heading of Electric Candles, those of De Meritens, Wilde, and Rapiéff are mentioned in addition to the well-known Jablochhoff "candles." Some account is also given of the chief experiments recently made in this country on the various systems of lighting. The manufacture of the carbon pencils for producing the arc is very briefly treated: too briefly, considering that this is the very point in which there exists at present the greatest room for improvement.

Some of the expressions used by Mr. Shoolbred strike us as warranted neither by their scientific accuracy, nor by popular usage. Thus on p. 95 we find, on the question of the subdivision of the light, the following sentence: "The product of each electrical circuit may, it would appear, be fairly considered as the *unit of output*." On

p. 96: "The *output* of a machine with regulators does not readily divide itself." This term "*output*," which in these instances, and on p. 11, is used for quantity of current generated by the machine, occurs again on pp. 65 and 66 for the amount of light emitted! The statement on p. 50 that "the very production of the electric light depends upon the conversion of a certain amount of mechanical *duty* into electrical *force*," would certainly draw down the wrath of sticklers for scientific accuracy. The suggestion to produce the voltaic arc between incombustible electrodes so as to avoid the production of nitrous fumes, "and the very fact that the use of carbon electrodes led to the development of such baneful emanations," can hardly be endorsed as a piece of chemical wisdom.

These blemishes, however, and a prevailing inelegance of style, show that a general acquaintance with a scientific subject will not alone qualify its possessor to be regarded as an authority.

For general merit and usefulness the treatise of Dr. Higgs on the electric light in its practical applications will take high rank. Avoiding historical details and points of abstract theoretical interest, the author begins by describing the various lamps and "burners" devised for producing electric light; he then goes on to enumerate the various generators, and to discuss their relative efficiency and economy, illustrating every point where possible by carefully tabulated results of experiment; and concludes with a notice of various useful applications. Many sources of information have obviously been laid under contribution; the report of the Franklin Institute, that of Professors Houston and Thomson, and the very valuable paper of Mr. Preece on the question of multiplication of lights, being reproduced almost entire. The recent and instructive report of Dr. Oelhausen is also quoted in the chapter on Commercial Aspects. Chapter viii. is devoted to electric "regulators," a term which we discover the author to apply to devices, not for regulating the arc, but for controlling the strength of the current. He rejects the term "regulator" in its usual application, preferring to speak of electric "lamps" and "burners." On page 196 is given a table of the various and singularly divergent measurements which have been made of the intensity of illumination of the Jablochhoff candle. A summary of the report of the Gas Light and Coke Company's Committee is also given, and the prejudiced nature of that document is clearly demonstrated. A few blunders require attention. Thus the formula on page 198 for estimating the useful effect of distributed lights is hopelessly wrong. Again, while there is on page 169 a statement that the light is proportional to the current, we find on page 214 a sentence which would lead us to imagine the author's opinion to be that the light was proportional to the fourth power of the current! We doubt, too, whether it has yet been shown that "the hissing noise produced by the electric arc is due to the formation of a vacuum round the incandescent points." The statement that "a tuning fork with its prongs two yards in length will vibrate less than once in two seconds" is misleading, and not necessarily true. These defects apart, the book is a good one; and the illustrations, which are numerous, strike us as being, for the most part, superior to the average of those of scientific books. But why should the

author advertise himself as the author of "Electric Lighting," which is the title—if we are not mistaken—of his translation of Fontaine's well-known work?

SILVANUS P. THOMPSON

### THE DOLOMITE REEFS OF THE SOUTHERN TYROL AND VENETIA

*Die Dolomit-Riffe von Süd-Tirol und Venetien. Beiträge zur Bildungsgeschichte der Alpen.* Von Edmund Mojsisovics von Mojsvár. Pp. 552, with 30 Photographic Plates, 110 Woodcuts, and an Atlas in 6 sheets. (Vienna: Holder, 1879.)

THERE are few districts in Europe which have attracted so much attention from geologists as that which is described in the splendid monograph now lying before us. Whether we consider the richness and variety of the palæontological treasures yielded by the world-famed deposits of St. Cassian, the wonderfully-dissected volcanic centres of Monzoni and Predazzo, or the remarkable illustrations of the action of denuding forces still at work in the Alpine regions, as illustrated by the picturesque ruin-like masses of the dolomitic limestones and the singular earth-pillars of Botzen, the area must be admitted to be worthy of the celebrity which it enjoys among the cultivators of all branches of geological science.

The author of the present work possesses a remarkable combination of the qualifications necessary for the successful accomplishment of the task he has set himself. A daring Alpine climber, he has explored the most inaccessible recesses of the district during the summer months, while his winters have been devoted to the study of the grand assemblage of fossil-forms which he has brought together with such untiring industry. The manner in which Dr. Mojsisovics is performing this task of describing the enormous series of fossils of the Alpine Trias—an assemblage of forms possessing so many features of interest on account of the remarkable admixture of Palæozoic and Mesozoic types which it presents—is familiar to all palæontologists. He has shown that at Hallstadt and St. Cassian respectively we have evidences of the existence of two distinct life-provinces in the Triassic seas, and his monographs on the cephalopods of these two life-provinces, the first instalments of which have already appeared, have excited the greatest interest among naturalists, who were scarcely prepared even by the writings of von Hauer and other illustrators of the fauna of the Alpine Trias, for the new and remarkable varieties of the Ammonite type, now brought to light by the author of this work. The current number of the *Verhandlungen der k. k. geologischen Reichsanstalt*, of Vienna, contains an interesting summary of this new work, and shows that no less than thirty-two Ammonite genera have up to the present time been recognised in the Alpine Trias, of which thirteen are peculiar to the northern life-province, five are restricted to the southern life-province, while fourteen are common to both. Although Dr. Mojsisovics's work has, up to the present time, been confined to the Cephalopoda, yet we anticipate results of scarcely less interest when he arrives at the examination of the Gasteropoda and the other classes of fossils obtained from the Alpine Trias.

The work before us is in great part the result of the investigation of the Austrian Geological Survey, carried on under the direction of Franz von Hauer, and much of the detailed examination of certain of the districts described was accomplished by two of the author's former colleagues Dr. Hoernes and Dr. Doelter; the account of the volcanic and granitic rocks is indeed almost entirely supplied by the latter geologist, who is so well known for his skill in micropetrographic researches. The most important part of the work, however, is that which is devoted to the description of the several Mesozoic formations of this Alpine area, and to a discussion of the important facts concerning the former physical geography of the region, and the distribution of life-forms within it—questions which the author is so well qualified by his long study of the subject to treat of.

As a consequence of the representations made to the Academy of Sciences of Vienna by von Hauer, Suess, and Hochstetter, a special grant of money was made to aid the author in the publication of this valuable monograph, and no expense has been spared to make both the book itself and the atlas which accompanies it, of the greatest possible value. In these respects the work resembles the publications of the American Geological Surveys much more than those of our own country.

The atlas contains six sheets, comprising an area of about 3,000 square miles, and is constructed on a scale of  $\frac{1}{72000}$ , or about  $\frac{1}{8}$  of an inch to an English mile. The foundation of the map is, for the southern or Italian part, the old general map of the Austro-Hungarian Empire on the same scale, and for the Tyrolese area the new military map of Austria on a scale of  $\frac{1}{36000}$ , which has been reduced by photography. The geological colouring is admirably printed, and although between forty and fifty different tints have been employed to indicate the numerous subdivisions adopted by the author, this is accomplished without creating confusion, or obscuring the topographical details of the map. The district comprised in it includes the country lying between the Adige and the Piave, from Toblach, on the north, to Feltre, on the south, the larger portion of which is included in the Austrian Tyrol, but a considerable area in the south-west now belongs to the Italian monarchy.

The memoir itself is illustrated by thirty reproductions of photographs taken either by the author himself or by Egger of Lintz, the points of view in the latter cases having been chosen by Dr. Hoernes. These views give an excellent idea of the remarkable natural features presented by this very interesting district, the now famous "Dolomite Mountains." In addition to these views and the very numerous woodcut sections, there is also a series of maps illustrating the areas of the old coral reefs and the lines of disturbance traversing the district.

The first or introductory part of the memoir, consisting of four chapters, gives a general sketch of the geology of the district and of the physical features of the Southern Tyrol. The second part (Chapters V.-XV.) is devoted to a detailed description of the geological structure of the several districts, while the third and concluding part (Chapters XVI. and XVII.) deal with theoretical questions of great interest to geologists at the present time, namely, the reef-theory of von Richthofen and the origin and mode of formation of mountain chains. We regret

that the space at our disposal will not permit of our following the author in these interesting discussions, and we can only, in conclusion, heartily recommend the work to the traveller as being admirably adapted to guide him in investigating the geology of a district of extreme interest and great complexity, and to the student at home as containing numerous facts and suggestions worthy of the most thoughtful consideration.

J. W. J.

### HEALTH PRIMERS

*Health Primers.* Edited by J. Langdon Down, M.D., F.R.C.P., Henry Power, M.B., F.R.C.S., J. Mortimer-Granville, M.D., John Tweedy, F.R.C.S. (London: Hardwicke and Bogue.)

THE proverb that a little knowledge is a dangerous thing is especially true in regard to matters connected with health, and it might therefore be supposed that the issue of a series of health primers was a thing to be deprecated, as likely to do harm. But a little reflection will show that this series is intended, not to impart a little knowledge, but to replace the knowledge, not merely little, but confused and inaccurate, which every man supposes himself to possess, by something more definite and exact. Every one fancies that he knows the appearances of health and disease, and that he is able to decide upon the condition of those whom he daily meets. Every man supposes himself able to pronounce that such and such a house cannot be healthy, and believes that he is quite capable of judging for himself how much exercise he ought to take, whether he should or should not use a cold bath in the morning, and what is the proper allowance of beer, wine, or spirits, either for himself or for his neighbours. Now, despite the confidence with which most men will pronounce an opinion on all these subjects, the data on which they would found that opinion would really be very slight, and their knowledge of the subject probably very imperfect and inaccurate, and, consequently, the conclusions at which they would arrive would most likely be erroneous. It is just on such subjects as those we have mentioned that the books of this series afford accurate information. The first of them, "On Premature Death, its Promotion and Prevention," is of a less popular character than the others, and has, we think, suffered in consequence of its author not having seen the contents of the other primers. While the material it contains is very valuable, it deals, we think, too much with statistics and too little with the causes of premature death which are under the control of the individual, although occasionally, however, it gives these also, as at p. 46, where ventilation in a hospital is said to have put a stop to the convulsions from which the children died in great numbers, and reduced the mortality to  $\frac{1}{3}$  of its previous amount. But on the other hand, while we learn that 6 per cent. of the total mortality from all causes is due to diseases of the heart, the writer says nothing of the dangers incurred in running after an omnibus or in trying to catch a train.

The primer on "Personal Appearance in Health and Disease" includes the changes which the body may undergo in the form and size of its bony framework, fatty layer, and internal organs, as well as external colour. These are given shortly and well, though the alterations

produced artificially by tight-lacing and high-heeled and tight boots might have been still more strongly insisted upon and emphasised by woodcuts showing their results.

"The House and its Surroundings" is clearly written, and contains a great deal of very useful information. By its aid the householder should be able to know where to look for defects in drainage, ventilation, water supply, &c., and thus to avoid many sources of disease, although we think that the dangers of arsenical wall-papers ought perhaps to have been more strongly insisted upon.

"Baths and Bathing" discusses the physiological action, varieties, and uses of baths and bathing localities, both at home and abroad. It is written in a very readable style, and contains both advice as to the use of baths and cautions in regard to their abuse. The author warns against the too heroic use of a morning tub, but forgets to state how very much the chilliness which it brings on in persons of languid circulation may be prevented by using a bath sheet instead of a towel, so that the whole body shall be covered during drying, and not chilled by the exposure of the wet skin to the cold air.

"Exercise and Training" gives a general account of the changes produced in the body by muscular exertion, of the food required, the general régime to be pursued, and the dangers to be avoided. It is evidently written by one who is familiar with the subject of which he is treating.

"Alcohol, its Use and Abuse," deals with a very difficult subject, and does it well. The author is not prejudiced either for or against alcohol, and maintains that because ninety-nine persons out of a hundred misuse it, it is none the less true that it has a right use, this use being sometimes to check the current of thought and care, as well as to stimulate digestion and circulation, although in perfect health its use is unnecessary.

The purpose which these primers are intended to serve is a very important one, and we think that they are well calculated to serve their purpose. We have pointed out one or two things in which we think they might be improved in future editions, but on the whole they are well and carefully done, giving accurate information in a condensed yet popular form.

T. L. B.

### LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

#### The Mechanical Theory of Earth-Heat

NOTICING the assertion made in *NATURE*, vol. xx. p. 22, in reference to Prof. Church's article in *Silliman's Journal* on the Comstock Lode, that "the rock in the lower levels seems to have a pretty uniform temperature of 130° F.," and remembering what Prof. G. F. Barker, of the University of Pennsylvania, told me, that on a recent visit to those mines he found that there was no uniform temperature, but on the contrary, the most remarkable differences, some of the higher levels being much hotter than some of the lower levels—so that he came to two conclusions:—(1) That the heat was a hot water heat, and (2) that the hot waters were heated mechanically by those continuous movements of the country, so plainly shown both in the mines and at the surface;—it occurs to me to ask the following question:—

Has any one, in the discussion of Mallet's hypothesis, thought of bringing its probability to such a test as the volatilisation of the hydrocarbons of coal-beds in a highly plicated region like Belgium?

It is a remarkable fact, and one which seems to me inconsistent with the mechanical theory of earth-heat, that of two extensive regions, Belgium and Eastern Pennsylvania, equally and excessively disturbed by complications, all the coal-beds of the one are anthracite, and all those of the other are bituminous.

Again, of two regions equally undisturbed, Western Pennsylvania and Arkansas, the horizontal coal-beds of the one are bituminous and of the other anthracite.

Surely, if movements of stratum on stratum produce all the needful heat, no plicated coal-beds should escape being converted to anthracite; and I should much like to hear from English geologists how this argument is to be met. My own explanation of the origin of anthracite is not worth much, but it is the best I know. I refer such origin to three causes acting in conjunction—(1) Heat due to superposed (now wholly or partially removed) Permian and later formations; (2) Greater proportion of sands in the anthracite and of clays in the bituminous coal-measures; and (3) Plication and fracture, permitting the exit of volatilised hydrocarbons into the atmosphere.

American Philosophical Society,  
Philadelphia, May 22

J. P. LESLEY

#### Evolution Old and New

MR. A. R. WALLACE writes, in *NATURE*, vol. xx. p. 143, that, according to the theory which I support, Australian (and more especially Queensland) sheep should show a tendency to grow a scantier and thinner fleece than their English ancestors. "If Mr. Butler," he continues, "could adduce on good authority such a fact as this, he would have some evidence in his favour, instead of which he can only make suppositions."

I never was in Australia, but had some years' experience of sheep-farming in New Zealand. It was generally believed, in my time, that fleeces soon became short and hairy in Queensland, and even in the more northern part of New South Wales. You must, however, have many readers who could tell us what the facts are. May I hope that you will kindly insert this, so as to get the matter settled by eliciting information from a competent authority? I am speaking, of course, of sheep that are left to the effect of the climate, without being frequently crossed with rams from colder countries. Do the fleeces of such sheep deteriorate in Queensland?

S. BUTLER

June 12

#### The River Elbe

IN *NATURE*, vol. xiv. p. 498, some particulars are given of measurements made in 1871 and 1872 of the water flowing past in the Elbe at the boundary between Saxony and Bohemia. The river basin in Bohemia above this point is stated at 880 square miles, which is evidently wrong, as the annual discharge of 6,179,000,000 cubic metres (218,223,743,000 cubic feet) would give a depth of 107·64 inches run off the ground. Measuring roughly on the map, the area of Bohemia—which, apparently, all drains into the Elbe—is 20,000 English square miles. If, on the other hand, the measurements of the river water and the solids in solution and suspension are correctly given, and the river basin is 20,000 square miles, the rainfall must have been exceptionally low at the time the measurements were taken, as the figures represent only about half that of the mean annual flow off the ground in the Danube basin, which is 9·06 inches. Perhaps the writer of the notice will be able to find out how these discrepancies occur. I may add that, taking the figures as given in *NATURE*, 607 tons per square mile per annum are removed in solution in the Elbe water. From a district composed mostly of silurian rocks, this is manifestly absurd. According to my calculations,<sup>1</sup> 72·7 tons per square mile are annually removed in solution in the Danube water.

Blundellsands, June 17

T. MELLARD READE

#### Electric Light

IN *NATURE*, vol. xx. p. 110, an account is given of Sir William Thomson's evidence on the electric light. It is stated "that one horse-power had produced 1,200 candles of actual

<sup>1</sup> "Geological Time," *Proceedings of Liverpool Geological Society*, Session 1876-7.

visible electric light, whereas one horse-power of energy would only produce 12-candle gas-light." In the report of Sir J. W. Bazalgette and Mr. Keates to the Board of Works, which is probably the best report we have yet had on the subject, as to the actual cost of the electric light on the Thames Embankment, it is stated that the cost of the electric light was 5·75d. per hour, whereas the cost of the gas required to produce a light equal to the electric light as regards illuminating power, in an opal globe, was 2·00d., and in a frosted globe 3·50d. per hour. Would any of your numerous readers be kind enough to give me some idea of the qualifications to be appended to the above statements, which will reduce the long odds calculated by Thomson of 100 to 1 in favour of the electric light, to the odds of 2 to 1 against it as found in actual practice? In conclusion may I venture humbly to suggest that such conflicting statements as the above, if unexplained, are apt to bring the dicta of scientific men into disrepute with the thinking portion of the general public.

F. J. M. P.

#### The Climbing Perch

THE aquarium of the Zoological Society's Gardens in Regent's Park has lately received a contribution of five specimens of the "Climbing Perch" (*Anabas scandens*). They were very kindly obtained for me by my friend, Mr. A. Ferguson, of Colombo, Ceylon, and were brought home in excellent condition by my brother, Mr. A. F. Dobson. Mr. Ferguson (who is so well known in Ceylon as a naturalist of great experience) kept the fish for some months in an aquarium, and trained them to take chopped meat from the hand, so that they were in the best possible condition for their long journey.

The first specimens of this fish which arrived alive in Europe were sent by me from Calcutta in 1872 to the Royal Zoological Gardens in the Phoenix Park in Dublin, where they lived for a considerable time.

I have described (P. Z. S., 1874), in my paper "On the Respiration of Indian Fresh-water Fishes," the manner in which *Anabas scandens* takes in, and rejects again, the atmospheric air, and on a visit to the aquarium in the Gardens the peculiar conduct of these fishes when respiring may be witnessed by any one.

Mr. Ferguson informs me that he has specimens of some species of *Ophiocephali* and the remarkable *Arius bakeri*, which carries its young in its mouth, in training, and I hope soon to have an opportunity of having them safely carried to England.

Netley, June 14

G. E. DOBSON

#### Oxygenated Rain

ON Thursday, June 12, at half-past eleven in the morning, a remarkable shower of rain fell over London, which might almost be described as "effervescing;" the drops whilst falling appeared to be colourless and perfectly transparent, but on striking against any solid surface they became milky, and on close examination it was evident that this cloudy appearance was caused by a number of very minute air-bubbles, which rapidly increased in size, and then burst. From the bleaching power which this rain appeared to have, I am led to believe that there was nascent oxygen in the gas thus evolved. Those who traverse the streets of London in the early morning may now and then observe the red colour of all bright iron-work in the pavement, such as coal-plates, &c., due to the oxidising influence of a thunder-shower in the night; this effect does not follow every thunder-shower, but seems to indicate a peculiar atmospheric condition. Have any memoranda on this subject been recorded?

EDWARD SOLLY

#### WILLIAM FROUDE<sup>1</sup>

LAST week we called attention to Mr. Froude's discoveries of those laws of motion of floating bodies, upon which the behaviour and safety of a ship passively floating among sea waves depends. We now purpose giving a brief outline of his researches in another branch of hydrodynamics by which he arrived at a true appreciation of the nature and amount of the resistance opposed by water to the passage of a body like a ship through it. In connection with the resistance of ships, the subject of marine propulsion, which Mr. Froude has also done much

<sup>1</sup> Continued from p. 150

to elucidate and bring within the grasp of scientific treatment, will naturally find a place.

The resistance of ships and the speeds that could be relied upon in practice by the application of a given amount of force has always been a fruitful source of trouble to naval architects and engineers. The various formulæ that have been used for calculating the speed of ships, and which were based upon what were supposed to be the true laws of resistance, have always been uncertain and unreliable in their application. Mr. Froude has shown that this is because the approved formulæ "were not only wrong in detail, but that the supposed cause of resistance, with which alone they professed to be dealing, was in reality no cause at all; and that the real cause of resistance, whatever it might be, was entirely left out."

This supposed cause of resistance, which "was in reality no cause at all," was alleged to be due to the inertia of water, and the necessity for pushing those particles out of the way which offer an obstruction to the progress of a ship through the fluid. Thus it seems that there must be an excess of pressure upon the fore part of a ship when she is excavating or pushing water out of her way; and a diminution of pressure or partial vacuum on the after part when she is travelling away from the particles which press against her. There would therefore be a total resistance caused by excess of pressure forward and deficiency of pressure aft. As this resistance would depend upon the volume of water that would have to be pushed out of the ship's way; it appeared obvious that it must be measured by the area of the ship's cross section.

These considerations were expressed in the following formulæ, which have been those chiefly used by ship-builders till the last few years, and have been preferred by the Admiralty to any other down to the time when they placed the determination of the speeds of ships in Mr. Froude's hands. The formulæ are—

$$V^3 = \frac{C_1 A}{P} \text{ or } = \frac{C_2 D^3}{P}$$

when  $V$  = the speed of the ship,  $A$  = the area of the greatest immersed cross-section, or "the area of the ship's way,"  $D$  = the ship's displacement,  $P$  = a measure of the propulsive force, which stands for the indicated horsepower of the engines, and  $C_1$  and  $C_2$  are constants obtained from the observed performances of other ships. These are only formulæ of comparison between different ships, and were always regarded as being strictly applicable only to the comparison of ships of similar form. They are obviously based upon the assumption that the resistance is as the square of the speed and the area of the vessel's way, or of the canal she may be supposed to cut through the water in going from place to place. This is strictly the assumption in the first formula, which includes the exact area of the immersed cross-section of the vessel; but in the second formula, though the character of the assumption is the same, the area is corrected to represent the supposed equivalent cross-section for variations of displacement.

These formulæ gave fairly accurate results when applied to vessels of good form which were similar to those from which the constants were derived, and when the speeds were low. It was known, however, that the speeds of vessels of exceptional form and dimensions could not be thus calculated, and that in all ships the resistance increased at a faster rate than the square of the speed beyond certain limits, which limits were different in different ships. The development of the true laws of fluid motion, or the doctrine of stream-lines, by Prof. Stokes, Prof. Rankine, Sir William Thomson, and others enabled the real causes of a ship's resistance to be ascertained. It was then seen to be quite wrong to suppose that the work done in propelling a ship is in any degree analogous to excavating a canal, and spreading the water she successively displaces over the surface.

The stream-line theory showed that the reactions which the inertia of the fluid would cause against the surface of a ship moving through it arranged themselves quite differently to what had formerly been supposed, and that such methods of estimating their total effect—which was supposed to constitute the resistance—as we have referred to were fundamentally wrong. Indeed it shows that there is nothing in nature to correspond with the old idea of head resistance, because, according to the stream-line theory, a submerged body such as a fish, or a torpedo, once put in motion in a frictionless fluid would continue to travel with an uniform speed, and experience no resistance. Certain particles of fluid would have to be set in motion to enable such a body to pass them, but this would be done in such a way as to cause no resistance in the direction of motion. The backward forces acting upon the body on some parts of its surface would be balanced by the forward forces acting upon other parts, and the inertia of the fluid would propel it forward at some points with an equal force to that opposed in resistance at other points.

Mr. Froude showed most clearly and conclusively how this paradoxical result came about in his presidential address to the mechanical section of the British Association delivered at Bristol in August, 1875,<sup>1</sup> and also in a lecture delivered at the Royal Institution on May 12, 1876. He proves that in a perfect or frictionless fluid there is no power by which any endways resistance can be caused to the passage of a submerged body moving uniformly through it. Substituting for the submerged body moving through a stationary ocean of fluid the plainly equivalent conception of a stationary submerged body surrounded by a moving ocean of fluid, Mr. Froude points out that at a sufficient distance ahead of the body the ocean is flowing steadily on, in what may be imagined to be a collection of streams of any size and cross section we please. All these streams must have the same direction, velocity of flow, and pressure. In order to get past the body these streams must alter their direction and velocity, settling themselves into courses which will be determined by the various reactions they exert upon each other and upon the surface of the body—"yet ultimately and through the reverse operation of corresponding forces, they settle themselves into their original direction and original velocity. Now the sole cause of the original departure of each and all of these streams from, and of their ultimate return to, their original direction and velocity, is the submerged stationary body; consequently the body must receive the sum total of the forces necessary to thus affect the streams. Conversely this sum total of force is the only force which the passage of the fluid is capable of administering to the body. But we know that to cause a single stream, and therefore also to cause any combination or system of streams to follow any courses changing at various points both in direction and velocity, requires the application of forces the sum total of which in a longitudinal direction is *nil*, provided that the end of each stream has the same direction and velocity as the beginning. Therefore the sum total of the forces (in other words, the only force) brought to bear upon the body by the motion of the fluid in the direction of its flow is *nil*."

A frictionless fluid would, therefore, offer no resistance to a submerged body moving through it. Mr. Froude next introduced the consideration of friction, which brings two causes of resistance into play. First, there is the friction proper which is due to the drag of the particles of water upon the surface of a body as it moves through it, and which is governed in amount by the area of the surface, and also by its nature, whether smooth or otherwise; and secondly, there is the defect of pressure at the rear end of the body caused by the stream, line motions being somewhat impeded by friction between the

<sup>1</sup> Published in NATURE of November 18, December 2, 16, and 30, 1875.

particles. This is very obvious in blunt-ended bodies where the stream-lines, instead of closing in round the rear end and exerting their due pressure in the direction of motion, force themselves into eddies and whirls. Mr. Froude calls this element of resistance "eddy-making resistance." It is imperceptible in ships of fairly easy shape, but is of large amounts in ships with very full sterns. He shows that a submerged body of good easy shape would practically experience no resistance except that due to surface friction, and the amount of resistance would be practically the same as that of a thin plane moving edgewise, which has the same area of wetted surface.

Mr. Froude next shows that when we come to the case of a ship or a body travelling at the surface, a new cause of resistance is introduced, due to the system of surface-waves which is generated. The variation of pressure in the stream-lines formed at the sides of a ship relieves itself at the surface by raising or lowering the level, and thus a bow and stern wave with a depression amidships are formed and carried along as the ship progresses. These waves, once made, however, require little force for their maintenance, so long as they are not swollen to abnormal dimensions by the increased wave-making tendency a ship possesses at high speeds. Other systems of waves are also generated and driven off from the ship in various directions by features of form that interfere with the natural courses of the stream-lines. There are, therefore, three great causes of resistance to a ship: 1, surface friction; 2, eddy making; and 3, wave genesis. Mr. Froude shows that the first, viz., surface friction, practically agrees with the resistance experienced by a plane of the same wetted surface drawn longitudinally through the water at high speeds, and that the eddy-making resistance is practically nothing in well-formed ships having fine ends; but that the wave-making resistance is so indeterminate in its character as to be incapable at present of direct calculation.

Mr. Froude estimated the total amount of a ship's resistance by means of careful experiments with a model made to her exact form. The method of doing this with accuracy is one of Mr. Froude's greatest and most useful discoveries. Model experiments of this nature that had previously been made were so misleading that it was generally believed to be impossible to infer the resistance of a ship from that of a small scale model. Mr. Froude saw, however, that all three elements of resistance followed the same laws in similar bodies, whatever the differences of size might be, and that all that was required to make experiments with models reliable was to discover the true scale of comparison. This scale, or law of comparison, he discovered, and stated as follows:—"If the ship be  $D$  times the 'dimension' (as it is termed) of the model, and if at the speeds  $V_1, V_2, V_3, \dots$  the measured resistances of the model are  $R_1, R_2, R_3, \dots$ , then for speeds  $\sqrt{D}V_1, \sqrt{D}V_2, \sqrt{D}V_3, \dots$  of the ship the resistances will be  $D^3R_1, D^3R_2, D^3R_3, \dots$ . To the speeds of model and ship thus related it is convenient to apply the term 'corresponding speeds'; the special feature of this "correspondence" being the fact that at such speeds precisely similar wave systems are generated by ship and model.

Mr. Froude tried in 1867 a large number of resistance experiments with models of various forms and dimensions, by towing them from the ends of 10-foot scale beams, connected with self-recording dynamometric apparatus, and mounted on booms projecting sideways from the bow of a steam-launch. Some of the results were in glaring contravention to the ordinary principles current at the time, and Mr. Froude invited Mr. E. J. Reed, C.B., M.P., who was then Chief Constructor of the Navy, to witness the experiments. Mr. Reed saw the necessity for fresh investigation, and by his recommendation a further series of experiments was sanctioned by the Admiralty.

These experiments were brought into further prominence by the action which was taken upon a report of a committee of the British Association in 1869, upon the stability, propulsion, and sea-going qualities of ships. On the recommendation of this committee an application was made to the Government for carrying out experiments upon resistance with actual ships of considerable size. Mr. Froude, who was a member of the committee, dissented from this report on the ground that the various elements of resistance and the laws of their operation "could be discovered with far greater facility and completeness by small-scale than by full-size experiments." The Admiralty requested Mr. Froude to conduct an extensive series of experiments with models; this he undertook and continued up to the time of his death with the greatest skill and success. The results thus obtained furnished data for determining the resistance of ships of various forms and dimensions to a considerable degree of exactness, and also showed what circumstances were favourable to speed and what were not.

This subject had an important bearing upon some of the inquiries instituted by the Committee on Designs for Ships of War, in 1871, and they requested the Admiralty to determine experimentally the actual resistance of a full-sized ship. The Admiralty accordingly ordered the requisite experiments to be made upon H.M.S. *Greyhound*, a vessel of about 1,150 tons displacement. The experiments were made under Mr. Froude's superintendence. The *Greyhound* was towed by H.M.S. *Active*, and the resistance at various speeds recorded by means of a delicate dynamometric apparatus. She was towed from the end of a long outrigger boom, so as to be clear of the wake of disturbance, and every possible precaution was adopted to eliminate all the various sources of error. The experiments verified to a remarkable degree the law of comparison propounded by Mr. Froude as governing the relation between ships and their models, and perfectly justified the reliance he had placed upon his method of investigating the effects of variation of form by trials with varied models, a method which, as Mr. Froude afterwards remarked, "if trustworthy, is equally serviceable for testing abstract formulæ, or for feeling the way towards perfection by a strictly inductive process."

The value of Mr. Froude's method of calculating the speeds of ships from those of their models, became so obvious, that the Admiralty discarded their old methods, and referred their designs to Mr. Froude for his estimate of their speeds. Besides the elaborate series of experiments which Mr. Froude has had in course of procedure at his experimental tank at Torquay for determining the best form and proportion for various classes of ships, designed for various speeds, most of the new Admiralty designs have been experimented upon and modified forms suggested where improvement could be made. The results of his work, and especially of the recent trials of H.M.S. *Iris*, whose lines were determined by Mr. Froude for the high speed of  $17\frac{1}{2}$  knots—have borne striking testimony to the correctness of his work.

Mr. Froude has, however, done much more than show how to calculate with accuracy the speed of a ship from that of her model. He has shown how the various elements of resistance act upon a ship at given speeds, and the laws upon which they depend. In well-formed steamers the resistance at low speeds consists almost entirely of surface-friction. This was the case in H.M.S. *Greyhound* at a speed of eight knots. If a curve of total resistance be made from experiments with a ship or model, and a curve of frictional resistance be also placed on the same base line, they will be found almost identical at their low speeds. The resistance due to the formation of eddies is so small in well formed ships as to be hardly appreciable. When a ship of tolerably fine lines is moving at a moderate speed, the whole resistance, therefore, consists of surface-friction. As the speed

is increased, the curve of total resistance ascends more or less above the curve of frictional resistance, and in some cases departs very largely from it. The rate of departure as the speed increases differs largely in different ships, and in vessels of the same section, but of different lengths. Mr. Froude conducted a series of experiments upon models of the same cross section and form of ends, but with the length successively increased by lengths of parallel middle body. These models corresponded to ships of lengths varying from 160 feet to 480 feet in total length. At the lower speeds, up to about eleven knots, the resistance increased by about equal increments with equal increments of length of the ship, but at higher speeds this harmony disappeared. At thirteen knots the 200-foot ship makes considerably more resistance than the 240-foot ship, and at 14½ knots the 200-foot ship makes almost as much resistance as a 360-foot ship of 2,275 tons more displacement. Similar anomalies appear in the comparison between other ships. These were shown by Mr. Froude to be due to the influence of wave-making resistance, and to depend upon the positions occupied with reference to the stern of the ship by the waves generated by the bow. The practical point involved is that a ship may sometimes be lengthened considerably without any loss of speed for the same application of power; whereas if the conditions favourable to this are not complied with, she may, on the other hand, require a disproportionate increase of power to keep up her speed. Mr. Froude has shown how the most favourable conditions can be realised in this respect.

These investigations into the resistance experienced by ships at different speeds have thrown great light upon that long-disputed problem in naval architecture, "the form of least resistance," and has gone far to enable ship-builders to arrive at the best form and proportions for the speed required, which is compatible with other requirements. Economically such a discovery is of great value in enabling more work to be done in steamship propulsion for a given engine-power and expenditure of fuel.

Mr. Froude's dynamometric experiments upon the resistance of the *Greyhound*, and some results of the steam trial performances of other ships, showed him that the actual resistance of a ship was much less than had been generally supposed. At eight knots speed the pull upon the tow-rope of the *Greyhound*—a ship of 1,150 tons displacement—was only 2½ tons, and at ten knots 4½ tons. This was so very much below the thrust the screw was supposed to exert when driving the ship at those speeds, that Mr. Froude set to work to investigate the relation between the indicated horse-power of marine engines as represented by the work done by the steam in the cylinders, and the power that is usefully employed in propelling the ship. He found, as the result of many experiments, that in ordinary ships at full speed the former is 2·7 times the latter, or that the effective horse-power, as given out by the thrust of the screw, is only 37½ per cent. of the power indicated in the cylinders.

Mr. Froude decomposed the indicated horse-power of the engine into its constituent parts, and approximately quantified each element as follows:—

1. The useful thrust or ship's true resistance = E.H.P. or the effective horse-power.

2. The augmentation of the ship's resistance by the induced negative pressure under the stern consequent on the thrust of the screw. Mr. Froude often called attention to this cause of resistance, and showed that it might be greatly reduced by placing the screw a short distance abaft its usual position. He ascertained by experiment that with ships of ordinary form the resistance is increased on account of the action of the screw by about 40 or 50 per cent. of her nett resistance. The power required for this therefore = 0·4 E.H.P.

3. The friction of the screw blades in passing through the water, which was found to be = 0·1 E.H.P.

4. The constant friction due to dead weight and the tightness of the moving parts. This is at all speeds about one-seventh of the total load of the engines when working at full speed and pressure. It is therefore = 0·143 I.H.P., I.H.P. being the total indicated horse-power.

5. Friction due to working load of engine. This is also = 0·143 I.H.P.

6. Air-pump resistance. This is approximately equal to 0·075 I.H.P.

Summing up these several elements it will be found that the effective horse-power at full speed is little more than 37½ per cent. of the indicated horse-power.

This analysis of the manner in which the power of the engines is employed is very valuable in indicating the manner in which loss of power may be treated in detail, and also in furnishing a reliable means of comparison between the efficiency of different engines. It will take time to come into general use, but cannot fail to do so as it becomes understood and appreciated. Already some of our most intelligent shipbuilders, such as Mr. Denny of Dumbarton, and Mr. Inglis of Glasgow, have applied Mr. Froude's theories to practice, and are working upon the improved methods he has laid down both for increasing the effect in the propulsive power of the engines, and in diminishing a ship's nett resistance.

The general adoption of these theories will be a great boon to science, as well as a practical benefit, in point of economy to the ship-builder and ship-owner. Science will benefit by having the performances of ships recorded in such a manner as will be available for correcting the present theories, and throwing light upon such laws of hydrodynamics as are yet undiscovered or but imperfectly understood.

One great difficulty in making any scientific use of steamship performances has arisen from the absence of any method of determining the power delivered to the screw. All that was ever ascertained was the power indicated in the cylinders, and, as we have seen, this was found to be enormously in excess of the effective power employed in propulsion. As the problems of resistance and propulsion can only be accurately treated by dealing with the thrust exerted by the screw, it became desirable to have some means of measuring this in actual ships. Mr. Froude, who had frequently pointed this out, was asked by the Admiralty to devise a dynamometer that would measure the power delivered at the end of the screw shaft in large marine engines. The problem was a most difficult one, but Mr. Froude solved it in a most complete and admirable manner. He described the instrument he had invented in a paper read before the Institution of Mechanical Engineers in July, 1877, and a description of it is given in *NATURE*, August 2, 1877. It fulfils all the conditions of giving a true indication of the power, being simple, compact, and easy of application. A machine for dealing with an engine of 2,000 I.H.P. is all included in the circumference of a circle of three feet radius, and as its power increases as the fifth power of its linear dimensions, it can be applied to any size of engine without becoming unduly large.

We have glanced hastily over some of Mr. Froude's achievements in science, but it is impossible within the limits at our disposal to do more than glance at them, or even to refer to many. He was a scientific worker of the best and rarest type, and was constantly employed in perfecting the details of his theories or striking out new lines of thought. He was a master of the delicate art of experimental and theoretical investigation, and a study of his work would show many perfect examples of the manner in which, by induction, a knowledge of the causes of phenomena may be arrived at. Being an excellent mechanic, and a most conscientious and ingenious experimentalist, Mr. Froude put all his theories and

hypotheses to the most crucial and varied practical tests, and conclusively proved their truth, or determined the limits of error involved by them. He had the power of arranging almost intuitively simple experiments for qualitatively testing the value of an idea, and his mathematical knowledge and power of close and accurate reasoning enabled him to work out the quantitative results of a difficult problem with great facility. His experimental tank at Torquay, with all the delicate and interesting contrivances in connection with it for measuring and recording the behaviour of models in rolling or their resistance to motion through the water is a marvel of philosophical arrangement and practical skill. Mr. Froude's published papers include but a small portion, we believe, of his work. It would be a worthy tribute to his memory, and a great boon to science and to the shipping interests of the country if the result of his researches could be published in a complete form, and thus made readily accessible.

Mr. Froude had not much encouragement during the early days of his investigations upon these subjects. The first to appreciate their value were the late Prof. Rankine and Mr. Crossland, one of the constructors of the Navy. Mr. Crossland was one of the first to see that Mr. Froude, in his first paper on the Rolling of Ships, read before the Institution of Naval Architects in 1861, had indicated the true laws of rolling motion, and in the following year he contributed an original paper upon the same subject. Mr. Reed was the first to apply the principles enunciated by Mr. Froude to the construction of ships; and did so with great ability and success. Canon Moseley, Dr. Woolley, and others did not see, however, for a considerable time, that Mr. Froude had made a great stride in advance of previous knowledge, and had really discovered the means that had long been wanted of arriving at a due comprehension of the dynamical laws which govern a ship's behaviour at sea. Mr. Froude's lucid and painstaking explanation of his theory and replies to the objection of Dr. Woolley and others produced in due time their full effect, and in the course of a very few years all who were capable of understanding the arguments upon which the theory was based were thoroughly convinced that Mr. Froude's method and its results were sound, and were such as could alone lead to improvement in this branch of science.

Mr. Froude's scientific reputation and the value of his work now rest upon a solid foundation. His discoveries have revolutionised whole theories of hydrodynamics, and have stood the test of practical application. He has received various honorary distinctions, such as the degree of LL.D. from the University of Glasgow, and the Royal Medal of the Royal Society; but his greatest distinction, and that with which his name will always be associated, is that, in an age when science is fashionable and many of its professors look more to the show than the substance, Mr. Froude devoted his energies to a long and unwearied search after truth in a department of science that few knew anything about, and that could have no interest for the many, and he looked only to success for his reward. Happily, in this sense he was bountifully rewarded, and has left, both in the subject-matter of his researches and the example he set in pursuing them, a legacy to those who follow after which should stimulate them to work with all their might, with the one object of endeavouring also to attain unto truth and to be worthy of being admitted within the veil of the temple of nature.

#### KARL KOCH

THERE are very few even among professed botanists, who avail themselves to any thing like the extent they might do of the teachings of a garden. And yet for the study of the life-history of plants and for the due estimation of their precise degree of relationship one to the

other a garden offers in some ways—in many ways—unrivalled opportunities.

Karl Koch, whose death we lately recorded, was one of the few who had a right appreciation of the resources of a garden and who knew how to turn them to account. His tall, attenuated form and keen eye were to be observed at most of the International Botanical and Horticultural Congresses which have been held in various continental cities and in London in 1866. Everywhere, by horticulturists as by botanists, his claims to high rank among his fellows and his title to respect and even affection for his personal qualities were acknowledged, so that it became a pain to those who saw him recently to notice his gradually failing powers and to see how the old spirit was curbed and checked by impaired physical health.

Karl Koch was born in Weimar in June, 1809. In that little capital he came in contact, as a youth, with Goethe, and it was partly owing to his influence and advice that Koch made his visits to the Caucasus and various parts of Asia Minor. Shortly after he had completed his studies in medicine and natural history at Jena and at Würzburg he set out on his travels, his special objects being the investigation of the vegetation and an inquiry into the original sources of our cultivated fruit-trees. After two years' research he suffered so severely from the effects of sunstroke on Mount Ararat that he was obliged to return to Jena, but in 1843 he set out a second time for the East. Of his first journey an account was published in 1842, under the title of "Travels through Russia," of his second, in 1845, under that of "Wanderings in the East." A general account of his travels may be found in the *Linnaea* for 1848, in which publication also may be found catalogues and descriptive lists of the plants collected by him, together with remarks on the geographical distribution of plants in the Caucasus, &c. On his return from this second expedition he became assistant-director of the Botanic Garden at Berlin, secretary of the Prussian Horticultural Society, and, a few years later, Professor of Botany in the University.

His position at Berlin gave him exceptional facilities for studying cultivated plants, and, accordingly, much of his botanical work consisted of monographs of *Arads*, *Bromeliads*, *Agaves*, and other plants, necessarily imperfectly preserved in herbaria. Many such monographs are scattered through the *Wochenschrift* of the Berlin Horticultural Society, and which was for many years edited by him. As a pomologist also he held no mean position, but the most interesting and valuable part of his labours, so far as this branch is concerned, are those relating to the origin of cultivated fruit trees, a subject intimately connected with the history and migrations of our own race.

His *magnum opus*, however, is his "Dendrology"—a scientific description of the trees and shrubs cultivated in the forests and gardens of central Europe, a work for which his travels had well prepared him. For the purpose of compiling this volume Koch visited almost every country in Europe. All the great nurseries of the Continent and of our country were also inspected by him with the object of study or of securing specimens.

Despite small defects of method Koch's descriptions are excellent and characteristic, so much so, that it is a great pity that his work has not been translated into English. The technical details of his subject are enlivened by short biographical notices of the botanists and horticulturists whose names are the most prominently associated with the department of botany, of which his work treats. The reader of these interesting notes to an otherwise necessarily dry technical book will have no difficulty in understanding the estimation in which Koch's popular lectures on trees and on fruit trees in particular were held by the Berlin public.

In private life Koch was beloved for his uprightness, loyalty, and warm-hearted devotion to his friends.

### THE ELECTRIC DISCHARGE WITH THE CHLORIDE OF SILVER BATTERY

MESSRS. De La Rue and Müller, in the second part of the researches which they have carried on during three and a half years, have contributed facts of the highest value towards the solution of the problem presented by the beautiful phenomenon of stratification produced by electric discharges in vacuum tubes. The following are some of the more important results of these experiments as described by the authors.<sup>1</sup>

These phenomena, first noticed by M. Abria in 1843, were independently re-observed by Mr. (now Sir William) Grove in 1852, and have since engaged the attention of many physicists. The late Mr. Gassiot, working at first with an induction coil, but more recently on the same lines as the voltaic batteries of high potential,<sup>2</sup> published results of great interest; while, on the other hand, Mr. W. Spottiswoode is still pursuing with great acumen and originality a similar investigation, both with the induction coil and the Holtz machine, with which he has recently used condensers of great capacity.

Throughout our labours we have felt so strongly the necessity of obtaining numerical results as data for the foundation of a theory, that we have not hesitated to risk much in this cause. By the fusion of terminals, or the sudden discharge of the condenser, we have lost a vast number of very beautiful tubes; but gradually by the adoption of various devices, and by the employment of instruments specially constructed and insulated to suit the high potentials we deal with, we have succeeded in overcoming the various impediments, so that we can now readily obtain values for the physical quantities that enter into consideration in our experiments.

There is a serious trouble connected with the study of the discharge in rarefied gases, for, after a very short time, the tubes completely and permanently change, so as no longer to present the splendid stratifications witnessed on a first trial. We believe these changes occur much more rapidly with the battery in consequence of the greater amount of current, than with the induction coil; but the fact appears to have been well known to Dr. Geissler, of Bonn, who, on the occasion of a visit to our laboratory, brought with him some tubes through which no current had previously passed (virgin tubes, as he called them), which presented most beautiful phenomena lost for ever after too brief a period.

Tube 123 (cyanogen), for example, when first connected

with the battery, presented strata which completely filled the tube without leaving a dark space near the negative, some threading themselves on it, as shown on the left of Fig. 1; but after a few seconds the strata widened out as on the right hand figure, then other changes occurred, and the first phases have never been reproduced.

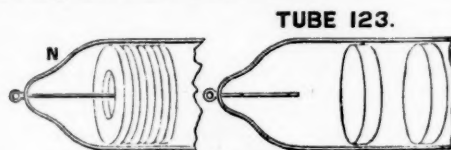


FIG. 1.

Another case is presented by the nitrogen tube Fig. 2, the right-hand figure showing the first phase, and the left-hand figure a second phase, which in its turn has for ever disappeared, and has been replaced by the ordinary disk-form of strata.

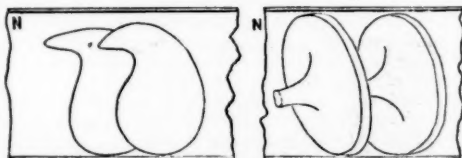


FIG. 2.

After spending much time in experiments with tubes prepared for us by Dr. Geissler, Messrs. Alvergmat Frères, of Paris, and Mr. Hicks, of Hatton Garden, with the vexation of finding that we could not often enough repeat our experiments, we ultimately came to the conclusion to have others made, but not exhausted, and to perform ourselves the charging and exhaustion. The tubes we usually employ have a glass stop-cock fitted to them at each end; they are 32 inches long, and from 1.75 to 2 inches in diameter; the terminals are of aluminium, and about 29 inches apart, one being a ring, the other a wire bent at a right angle, so as to point in the direction of the axis of the tube (see No. 144, Fig. 3), for we have found that the phenomena vary according as the ring or wire is made positive.

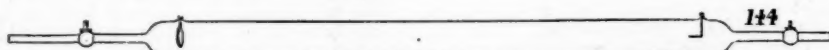


FIG. 3.

These we exhaust and fill with any gas we may wish to experiment with, and gradually exhaust again, noting the phenomena presented at different pressures, with different potentials, and with different amounts of current. We re-fill and exhaust the tube again and again, and mostly obtain, under the same conditions, as nearly as possible the same phenomena, of which we are careful to make sketches and, if possible, to obtain photographic records.

In some cases we make use of tubes provided with a

calibrated chamber between two stop-cocks, as *a-b*, No. 145, Fig. 4, the chamber in this particular case having  $\frac{1}{3200}$ th of the capacity of the tube, this tube has also an absorption chamber communicating through a cock and intended to contain spongy palladium. After a tube has been exhausted so as to produce a particular phase, and in the course of the experiment the exhaustion has been carried beyond that degree which permits of the reproduction of that phase, one or more charges of gas may be successively admitted into the tube by filling the calibrated chamber with gas at any particular pressure, and then opening the stop-cock communicating with the tube; the lost phase is thus reproduced.

The apparatus which we have found it advantageous to adopt for the exhaustion of our tubes is shown in Fig. 5; it comprises three means of exhaustion which are successively employed as the vacuum becomes more perfect. The first is an Alvergmat high-pressure water *trompe* in connection with the high-pressure water-main of the

<sup>1</sup> See *Phil. Trans.*, vol. clxix., pp. 55-121.

<sup>2</sup> Mr. Gassiot made several batteries of different kinds in the course of his experiments; on the occasion of a visit to his laboratory, January 26, 1875, the current of his Leclanché battery was measured by us with a voltmeter. The current of 1000 new cells was found to be 0.07464 W; that of the whole 3000 cells, 1000 of which had been a long time in use, 0.0718 W. Taking the Leclanché as 1.48 volt the internal resistance of the new battery must have been 19.83 ohms per cell; that of the whole 3000, 31.87 ohms per cell. The striking distance of the whole 3000 between a conical point and a disk 0.125 inch diameter was only 0.125 inch; whence the inference is that the insulation was, at that time, imperfect.

West Middlesex Water Company, the head of water being 106 feet; it produces a vacuum to within half-an-inch (0.47 in. = 12 millims.) of the height of the barometer. The pipe leading to it is so marked in the drawing; it is

attached, through a cock, to a four-way-junction-piece F, provided with three more cocks, communicating:—one to one end of the tube T, one to the last drying bottle of the gas generator G G', and one to a mercurial gauge. The

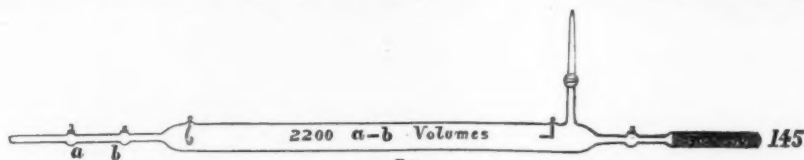


FIG. 4.

other end of the vacuum tube T communicates by means of a Y-piece to both, an Alvergmat mercurial pump, on the right of the figure, and a Sprengel pump, on the left. After the *trompe* has done its work, the Alvergmat is used for rapid exhaustion, and then shut off by means of the glass cock C, leaving the exhaustion to be completed by the Sprengel; we have thus obtained, by the pumps alone, in tubes 32 inches long and 2 inches in diameter, vacua of only 0.002 millimetre pressure, equal to 2.6 millionths of an atmo-

sphere—a vacuum so perfect that the current of 8040 cells would not pass. The apparatus is in connection with a McLeod gauge, by means of which pressures to 0.00005 mm. can be determined. Besides this gauge, the Sprengel and Alvergmat pumps have their own gauges, which read to a millimetre. M is a rotating mirror consisting of a four-sided prism mounted on a horizontal axis and provided with a multiplying wheel; on each face of the prism is fastened a piece of looking-glass. The reflection of the tube in the mirror enables one to examine

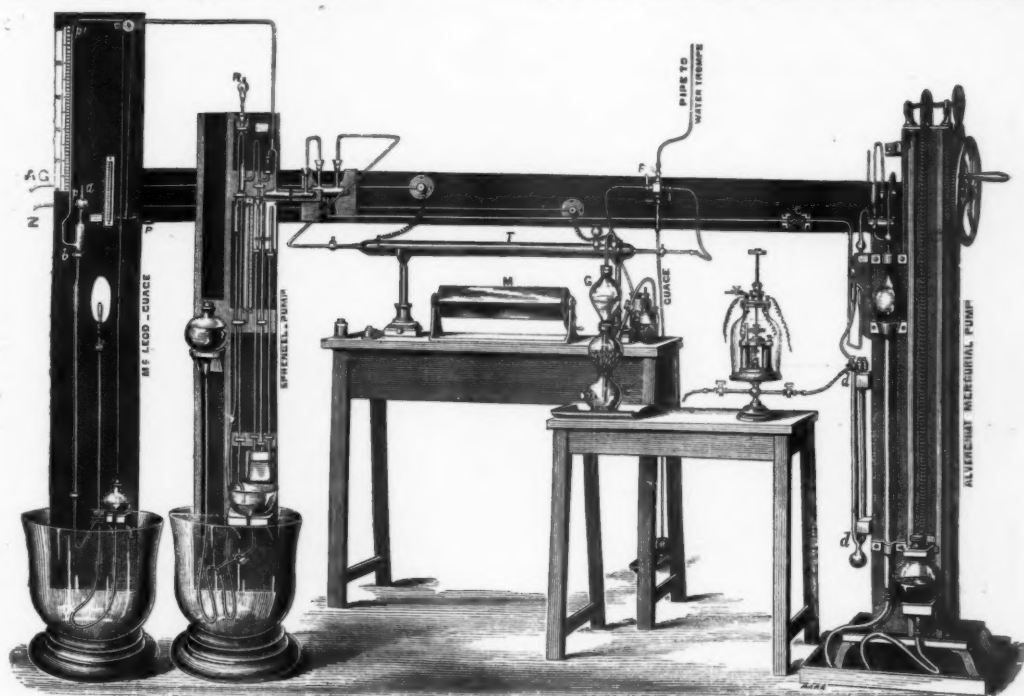


FIG. 5.

whether an apparently nebulous discharge is simply nebulous or consists really of strata, also whether and in what direction there is a flow of strata which may appear quite steady to the eye. The observations are facilitated by covering the tube with a half cylinder of cardboard having a slit in the direction of its axis about  $\frac{1}{10}$  inch wide. R is a radiometer attached to the Sprengel; d, d, a drying tube containing sticks of potash used when gas is introduced from a reservoir through the Alvergmat.

The resistance of vacuum tubes does not depend solely

or mainly on the distance between the terminal, but it does greatly on their diameter.

In order to test how much of this depends on the length of any constriction, we had made two tubes, 154 and 155, Fig. 6, of nearly the same length (16 inches), and internal diameter  $\frac{1}{8}$ ths of an inch, the residual gas in each case being carbonic acid,  $\text{CO}_2$ . From results obtained with these tubes where the constriction varied in length in the ratio of 125 to 1, it became evident that the main effect is due to the simple constriction of the tube.

The diagram Fig. 7, shows the arrangement by which,

In our early experiments, we measured the resistance of a tube. The tell-tale tube had to be substituted for the galvanometer in the ordinary Wheatstone bridge, as the difference of potential between C and D fluctuated greatly

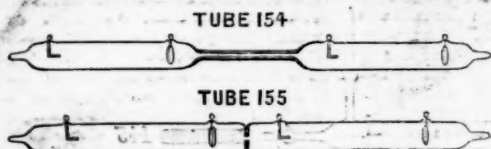


FIG. 6.

in the course of the experiment, causing violent swings of the needle.

A Z is the battery, the A terminal of which is connected at A, in the bridge arrangement, with two equal fluid resistance tubes, FR and FR', of 420,000 ohms, placed in vessels containing ice, to keep them at a constant temperature; an adjustable coil resistance is inserted between B and D; the tube T T', to be tested, is placed between D

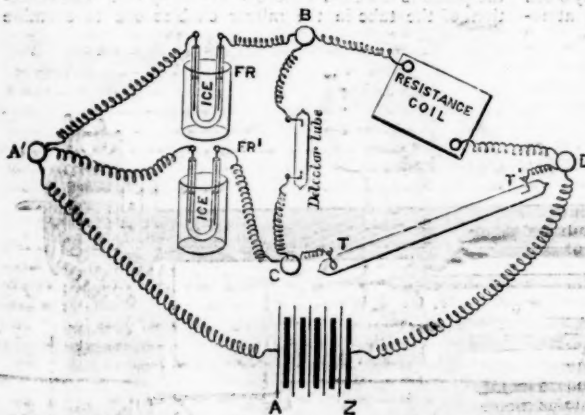


FIG. 7.

and C, the Z terminal of the battery being connected to D. When the resistance is greater or less than that of the tube to be tested there is an illumination in the detector tube between B and C; but when a current passes in T T', balanced by a proper adjustment of the coil resistance, then the glow in the detector ceases. It was ultimately found that the detector tube might be suppressed because, as soon as the resistance in B D is a little in excess of that of the tube, the latter gives evidence by its illumination

of the current passing. After the current in a tube has commenced it is generally found that it will continue to glow, even when some of the balancing resistance, B D, is plugged out in the coil box, showing that when once started the working resistance becomes less. If, on the other hand, the current has been stopped entirely, it requires generally a greater balancing resistance in the coil box between B D to start it again than it did in the first instance. After standing for a short or long time it regains its normal condition, but the interval required may amount to several days. The following numbers were obtained:—

| Tube | Started with ohms. | Ran up to ohms. | Nature of the Gas. |
|------|--------------------|-----------------|--------------------|
| 1    | 200,000            | 250,000         |                    |
| 2    | 330,000            | 500,000         | N                  |
| 6    | 270,000            | 500,000         | N                  |
| 42   | 15,000             | 70,000          | N                  |
| 81   | 150,000            | infinity        | CO                 |
| 95   | 700,000            | 1,000,000       | Si F <sub>6</sub>  |

Subsequently we found it to be more convenient not to make special determinations of the resistances of the tubes beforehand in the way just described, but to obtain them by reproducing the deflection of a galvanometer by substituting wire resistances for the tube, or by measurements taken with an electrometer in the manner to be described, while observing the phenomena of stratification.

From measurements thus made with a tube having several rings about 1 inch apart (No. 25, like in Fig. 9), or a Spottiswoode tube with a shifting terminal (No. 147, Fig. 8), we found that the resistance of a vacuum tube, unlike that of a wire, does not increase in the ratio of the distance between the terminals for the same gas at the same pressure.

In making these experiments it was noticed that the resistance for equal distances appeared to be greater in proximity with the negative pole than in other parts of the tube, and fresh experiments were in consequence undertaken to ascertain the potential at the several rings by means of a delicate Thomson-Becker quadrant electrometer furnished with an induction plate, I, Fig. 9, which may be adjusted to any required distance from the quadrant beneath it. The tubes employed among others were No. 25, described above, and two other longer tubes, namely, No. 149 (CO<sub>2</sub>) with 12 rings 2 inches apart, and No. 150 (CO<sub>2</sub>) with 17 rings also 2 inches distant. The current was led through a metallic resistance to the first ring, the last ring and the other pole of the battery being to earth. It was found that the greatest difference of potential occurs between the last ring and the last but one on the negative side, the next greatest difference being between the last and the last but one on the positive side, but the difference in the former case is far greater than in the latter; in some cases there is little or no difference

TUBE. 147.

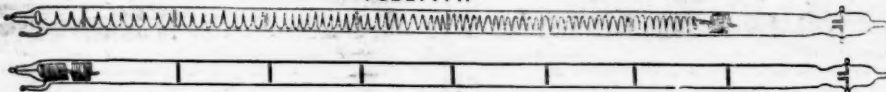


FIG. 8.

in the last but one and the last, but two on the negative side; in these cases the last but one on the negative side was dark, while all the others had a luminosity about them. The difference of potential between the rest of the rings is sensibly uniform.

The following observations, made December 21, 1877, with tube 150, may be taken as an illustration of the method of measurement adopted: Batteries 6 and 7

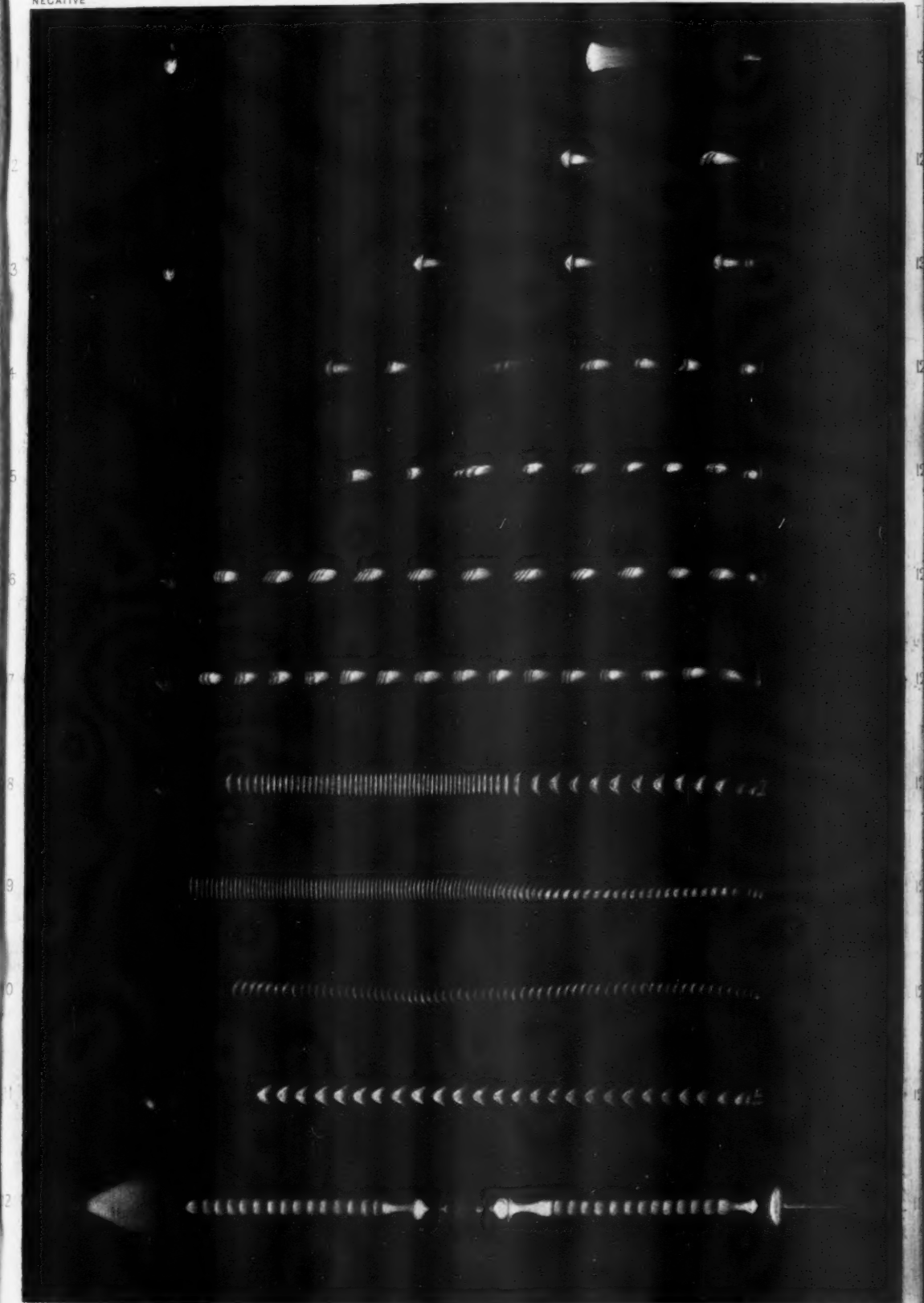
<sup>1</sup> A tube selected for the readiness with which it permits the passage of a current of 4 amperes.

(2,400 rod cells) were employed, and adjustable resistances were inserted in circuit for the double purpose of affording the means of readily varying the strength of current without interruption, and of enabling a measurement of that current to be made with the electrometer. The connections are shown in the diagram, Fig. 9.

<sup>2</sup> It has since been found more advantageous to separate the induction apparatus from the electrometer. Each pair of quadrants is charged with opposite electricities by means of two separate batteries of twenty chloride of silver cells, the opposite poles being to earth; and the induced plate of the induction apparatus communicates with the needle.

NEGATIVE

POSITIVE



FAC-SIMILE OF PHOTOGRAPHS.

D.J. Fand. Sculp<sup>d</sup>

*June*

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I. CIR

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II. C

The circuit was first broken by removing the earth wire from ring 17, and the plug T, in connection with the induction plate I, being touched at any point between K' and ring 1 gave the reading for "Full Potential, open circuit;" next, the earth wire was replaced at ring 17, and the value for "Full Potential, closed circuit," was

obtained by causing T to touch at K'. As these batteries had but small internal resistance, the difference between these two readings was scarcely perceptible. By touching T at rings 1, 2, &c., in succession, their potentials were observed. The current was then reversed and similar observations were made. Next, for the purpose of

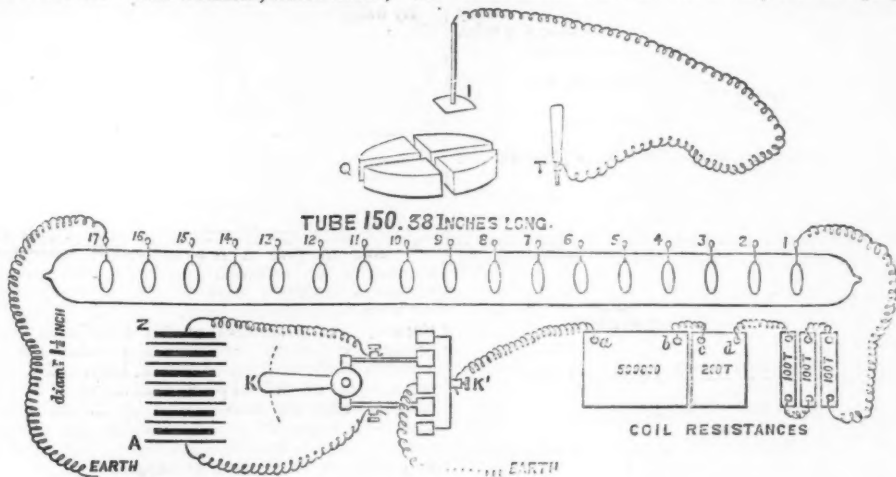


FIG. 9.

making a better examination of the tube in detail, the induction plate I was lowered to that distance which gave as large a deflection for the difference of potential between the two ends of the tube as was convenient. After the potentials of the several rings had been measured in succession with both currents, the induction plate was

restored to its original position, and one or two of the first observations were repeated for confirmation. The current was then varied by altering the resistance in circuit,<sup>1</sup> and fresh measurements made in the same order. Thus the following values were obtained:—

I. CIRCUIT:—2,400 rod-cells, 1 megohm resistance, Tube 150. Induction plate at 2 inches distance from the quadrant

| Current +                     |     |                 | Current -     |     |             |
|-------------------------------|-----|-----------------|---------------|-----|-------------|
| Zero                          | ... | 6 right = 0     | Zero          | ... | 6 right = 0 |
| Full potential (open circuit) | ... | 154 left = 160  | 200 "         | ... | 194         |
| " (closed " )                 | ... | 153 or 4, = 159 | 198 "         | ... | 192         |
| Potential at ring 1           | ... | 106 " = 112     | 133 "         | ... | 127         |
| " " 2                         | ... | 96 " = 102      | 108 "         | ... | 102         |
| " " 3                         | ... | not observed    | 100 "         | ... | 94          |
| " " 4                         | ... | "               | 95 "          | ... | 89          |
| " " 5                         | ... | "               | 89 "          | ... | 83          |
| " " 14                        | ... | 26 left = 32    | not observed  | ... | 127         |
| " " 15                        | ... | 20 " = 26       | 25 right = 19 | ... |             |
| " " 16                        | ... | 16 " = 22       | 20 "          | ... | 14          |
| " " 17                        | ... | 6 right = 0     | 6 "           | ... | 0           |

II. Circuit varied by substituting 800,000 ohms for the 1,000,000 ohms of wire, and inserting liquid resistance No. 3 (2,690,000 ohms) between the wire resistance and ring 1.

| Current +                     |     |                  | Current -                     |     |                  |
|-------------------------------|-----|------------------|-------------------------------|-----|------------------|
| Zero                          | ... | 1st Observation. | Zero                          | ... | 2nd Observation. |
| Full potential (open circuit) | ... | 5 right = 0      | Full potential (open circuit) | ... | 5 right = 0      |
| " (closed " )                 | ... | 159 left = 164   | " (closed " )                 | ... | 192 " = 187      |
| Potential after 800,000 ohms  | ... | 159 or 8, = 163  | " "                           | ... | 191 " = 186      |
| " at ring 1                   | ... | 139 " = 144      | " "                           | ... | 167 " = 162      |
| " " 2                         | ... | 112 right = 117  | " "                           | ... | 136 " = 131      |
| " " 3                         | ... | not observed     | " "                           | ... | 5 " = 0          |
| " " 4                         | ... | "                | " "                           | ... |                  |
| " " 15                        | ... | "                | " "                           | ... |                  |
| " " 16                        | ... | "                | " "                           | ... |                  |
| " " 17                        | ... | 5 right = 0      | " "                           | ... |                  |

<sup>1</sup> This method of varying the current is arranged to save time. The circuit must not be interrupted in the course of a set of observations.

III. The induction plate was lowered from 2 inches to  $1\frac{1}{2}$  inch. Current —. (The current + was not observed for want of time.)

|                    |     |     |     |     |     |     |     |     |     |     |    |    |    |    |    |    |    |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|
| Ring ... ..        | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| Readings ... ..    | 276 | 217 | 200 | 187 | 174 | 159 | 144 | 130 | 116 | 104 | 90 | 76 | 62 | 48 | 35 | 22 | 0  |
| Differences ... .. |     | 59  | 17  | 13  | 13  | 15  | 15  | 14  | 14  | 12  | 14 | 14 | 14 | 14 | 13 | 13 | 22 |

The observation III. illustrates that which has already been said concerning the fall of potential within the tube. In case I. we have for the currents in webers—

$$C + = \frac{47}{1000} \times 2400 \times 1.03 = 0.0007261, \text{ and}$$

$$C - = \frac{48}{1000} \times 2400 \times 1.03 = 0.0008281,$$

and for the difference of potential in volts ( $V$ ) between the two ends of the tube—

$$(C +) V = \frac{113}{1000} \times 2400 \times 1.03 = 1730, \text{ and}$$

$$(C -) V = \frac{114}{1000} \times 2400 \times 1.03 = 1618.$$

These differences of potential would be reproduced if for the tube were substituted metallic resistances in ohms ( $R$ )—

$$(C +) R = \frac{113}{1000} \times 1,000,000 = 2,383,000, \text{ and}$$

$$(C -) R = \frac{114}{1000} \times 1,000,000 = 1,954,000.$$

In case II.—

$$C + = \frac{19.8}{800,000} \times 2400 \times 1.03 = 0.0003674, \text{ and}$$

$$C - = \frac{21.8}{800,000} \times 2400 \times 1.03 = 0.0004190.$$

$$(C +) V = \frac{118.8}{1000} \times 2400 \times 1.03 = 1756, \text{ and}$$

$$(C -) V = \frac{119.8}{1000} \times 2400 \times 1.03 = 1736.$$

$$(C +) R = \frac{118.8}{1000} \times 800,000 = 4,780,000, \text{ and}$$

$$(C -) R = \frac{119.8}{1000} \times 800,000 = 4,142,000.$$

Selecting the observations with the current positive in each case and placing these in juxtaposition thus—

|         | $C$       | $V$  | $R$       |
|---------|-----------|------|-----------|
| Case I. | 0.0007261 | 1730 | 2,383,000 |
| „ II.   | 0.0003674 | 1756 | 4,780,000 |

we see that when  $C$  is varied in the ratio of 2 : 1,  $V$  remains sensibly constant,  $R$  varying as 1 : 2; that is to say, though the current is halved, the difference of potential between the ends of the tube remains constant—a condition which could only be brought about when metallic resistance is substituted for the tube, by doubling this resistance.

This points to the important conclusion that *other things being kept constant* and the current alone varied, we should find the value of  $V$  *strictly* constant for all values of  $C$ ; but it may readily be imagined that in experiments with “vacuum tubes” it is not easy to ensure perfect constancy of the accompanying circumstances.

To test this conclusion we extended the range of our observations by varying the value of  $C$  as much as from 1 to 135.

In the paper are given the original measurements themselves, not the mean results, in order that the discrepancies in the readings obtained for  $V$  when  $C$  was kept as constant as our powers of control permitted, might be compared with the variations, such as they are, in the values of  $V$  when the circuit was purposely varied so as to produce currents of different strengths. Our observations show clearly that discharge through rarefied gases cannot be at all analogous to conduction through metals; for a wire having a given difference of potential between its ends can permit one—and only one—current to pass; whereas, from the measurements obtained it became evident that with a given difference of potential between the terminals of a given vacuum tube, currents of strengths varying from 1 to 135 can flow. We are therefore led to the conclusion that the discharge in a vacuum tube does not differ essentially from that in air and other gases at ordinary atmospheric pressures—that it is, in fact, a disruptive discharge.

By fixing small rings of tinfoil to the glass near the places where the metal terminals are fused into the tube and connecting these rings to earth, we were able to cut off the leakage over the surface (which, in spite of precautions, is considerable), and prevent it from interfering with our measurements of the potential of the gas *inside* the tube.

(To be continued.)

#### NORTHERN BORNEO

SOME time ago (NATURE, vol. xviii. p. 454) we were able to give a few particulars respecting the acquisition, by a British association, of a considerable portion of Northern Borneo, a region which has never yet been thoroughly explored. Under the title of “North Borneo,” the promoters of this association have just printed for private circulation a 4to volume, containing a sketch of the territory of Sabah, lately ceded to them, and a report on various portions of the same by a Ceylon planter, which are accompanied by an analysis of soils and three appendices. The volume also contains two maps of Borneo, but the details given therein about the northern part are necessarily meagre.

The territory of Sabah comprises an area of some 18,000 square miles, possessing the great advantage of a coast-line of 500 miles from the Kimanis River on the north-west coast, to the Sibucu River on the east side of the island; it has the finest and almost only good harbours in Borneo, viz., Gaya Bay, Ambong, and Ousukan Bay on the west, and Sandakan Harbour on the east coast, the first and last named of which will, no doubt, become of great importance, especially if it be true that there is coal close at hand. The whole of Sabah is traversed by a mountain range of 5,000 to 8,000 feet in height, which culminates in the Kuni Balu mountain, 13,700 feet high. To the east of this is the supposed position of the Kuni Balu Lake, which no European has yet visited. On the shores of the lake, according to native reports, there are many villages of Ida'an, who cultivate cotton, tobacco, &c., and are said to be peaceful and industrious. There are numerous rivers on the north-west coast, but owing to the proximity of the high mountain ranges they are said to be only navigable by light craft; on the east coast, however, there are several splendid rivers, the Paitan, Sibucu, and Kinabatangan, the latter of which is believed to be navigable by large steamers for several hundred miles. As far as has been at present ascertained, the spurs and slopes of the Kuni Balu range seem well fitted for the cultivation of coffee, tea, and cinchona, and the level country on the banks of Kinabatangan for sugar, indigo, tapioca, tobacco, cocoa, cotton, and rice. The Sabah territory is believed to be but sparsely peopled, the total population being estimated at 150,000 to 200,000; the interior is inhabited by descendants of the aborigines, called variously Muruts, Dusuns, or Ida'an, and corresponding in their external appearance in many respects to the Dyaks of Sarawak and the southern parts of the island, though they are of a lighter hue. The climate of the region is believed to be very favourable; in the plains and low-lying lands near the sea and rivers an invigorating breeze is generally felt during the day, the thermometer seldom ranging beyond 86°, while the nights are cool, with a temperature sometimes below 70°. No data are yet available in regard to the rainfall, but it is believed to be very similar to that of Ceylon. The soil is rich and fertile, and in many locali-

ties of superior quality. The chief vegetable productions indigenous to the soil and growing wild in the forests are india-rubber and gutta-percha, baroos camphor and gum damar, and many valuable kinds of hard-wood timber. Rice, millet, tapioca, Indian corn, sugar-cane, tobacco, cotton, pepper, and many kinds of tropical vegetables are cultivated by the natives. The sago palm is found in abundance, cassia lignea is met with in some localities, and cocoa-nuts, the areca palm, mangoes, limes, oranges, bananas, and pine-apples are plentiful. Under the head of animal productions the report mentions edible birds'-nests, beeswax, hides and horns of cattle and deer, mother-o'-pearl shell, seed pearls, bêche de mer or trepang, and tortoise-shell; elephants exist in the Kina-batangan province in large numbers; rhinoceros, numerous deer of large and small breeds, and wild pigs are met with in many parts, but beasts of prey of the feline species appear only to be represented by a small cheetah in the interior. Minerals will, doubtless, be found in abundance in Northern Borneo. Gold occurs in several localities. Borneo diamonds are famous for their purity and water, and it is believed that they exist in Sabah as well as in Dutch territory. Tin, antimony, coal, quicksilver, iron, copper, petroleum, and other valuable minerals and metals, there is reason to believe, will be found in the territory of the association, but there has not yet been time for even a partial exploration of it from a geological and mineralogical point of view. The labour question may cause some little trouble. The population near the coast consists of Malays, Lianuns, Bajous, Sulus, and others of a mixed breed who are lazy, indolent, and averse to manual labour of any kind. The aborigines in the interior, Dusuns and Ida'an, are peaceful and docile, and accustomed to a certain kind of labour. But the company will not have to rely upon either for the development of their territory, for, as the report puts it, "the enormous amount of labour waiting for employment in the Chinese Empire, not more than three or four days' distance by steam from North Borneo, is at the disposal of intending planters and others . . . on reasonable terms."

#### VULCANOLOGY IN ITALY IN 1878<sup>1</sup>

A FEW years ago Cav. Michele Rossi, brother and collaborateur of the well-known author of "Roma Sotterranea," determined to try the experiment of collecting together from all parts of Italy facts connected with Vulcanology, and publishing an account of them in the form of a monthly fasciculus. He hoped by this means to found a new school for the study of endogenous meteorology, to be affiliated with the study of meteorology proper. The experiment has succeeded admirably, and we have before us a volume of 140 pages, recording all the phenomena of internal telluric dynamics which have been observed in Italy and Sicily during the past year. The vulcanology of Sicily, notably of Etna and the eastern sea-board, is also recorded in the Acts of the Accademia Gioenia of Catania. In no other part of Europe, except Iceland, would it be possible to have a journal solely devoted to the volcanic phenomena of one country. The kingdom of Italy contains within it the two most famous volcanoes in the world; it contains solfataras, soffioni, and maccalube; it is subject to earthquakes, sometimes of great severity, and spread over large areas; the district between Naples and Cape Misenum embraces almost every phase of volcanic phenomenon, excepting only the geysirs, and the Stufe di Nerone belong to this class of effects. Hence, obviously, there is no country of equal accessibility in the world which is so well adapted for the study of vulcanology.

The *Bullettino* opens with a tribute to the memory of

<sup>1</sup> *Bullettino del Vulcanismo Italiano. Periodico geologico ed archeologico per l'osservazione e la storia dei fenomeni endogeni nel suolo d'Italia. Redatto dal Cav. Prof. Michele Stefano de' Rossi. Roma, 1878.*

Padre Angelo Secchi, which is followed by a proposition to erect a monument to his honour. We were glad, a few weeks ago, to notice that a well-executed bust of the great Roman astronomer had already been placed among those of the many celebrities which adorn the Pincian Hill. The new monument will probably take the form of a *monumento meteorologico*, to be erected in Rome.

A list of twenty-six Italian observatories in which seismic observations are recorded is given in the *Bullettino*, with the names of the observers, who are in direct communication with Prof. de' Rossi. Among the minor notices we find mention of the proposed railway to the observatory of Vesuvius; of various new seismological observatories, including that of the Solfatara at Pozzuoli; and of the earthquake which was simultaneously felt at Fiumalbo, Florence, and Rocca di Papa. Bibliographical notices and correspondence find a place at the conclusion of the fasciculus. In the next number we find letters on the application of the microphone to seismological studies, from Prof. Michele Rossi and Count Giovanni Mocenigo, and later in the volume a very interesting article by the former details his experiments on the subject. The Umbrian earthquake of September, 1878, receives full description at the hands of Prof. Arpago Ricci; Silvestri gives an account of the mud eruption which broke out on the sides of Etna near Paternò in December; and Palmieri continues his "Cronaca Vesuviana" to the end of September, 1878. An exact account of the time of occurrence of earthquake phenomena in any part of Italy is entered in a tabular form, and it is surprising to notice that not a day passes in Italy without some indication of endogenous dynamic action. This also proves to us the sensibility of the instruments. The date is given, then the hour, the place, and the nature of the observation, thus:—

"13.—0.08 a. Messina, forte.—Reggio di Calabria, due scosse.—Palmi, scosse.—Capo Spartivento, molto forte.—Tropea, leggera ondul.

1.15 a. Corleone, leggera E—O, rombo.  
5.50 a. Tolmezzo, debole; altra poco dopo.  
7.15 a. Narni, sensibile N O—S E.  
Mattina Rocca di Papa, leggerissima.  
11.15 a. Bologna, leggerissima."

At the conclusion of the volume there is a large table showing at a glance the daily distribution of earthquakes throughout Italy. Twelve vertical divisions correspond to the twelve months of the year, and these are further divided by small lines into days. The horizontal lines serve to indicate:—

1. In the uppermost portion of the diagram the height of the barometer in millimetres. Thus we have the barometric curve for each month.
2. Here also is shown the variations during each month of the level of the water in the wells of Leghorn and Porretta.
3. Earthquakes according to the latitude.
4. Earthquakes according to the longitude, east and west of the meridian of Rome.
5. Daily maxima of the force of the shocks.
6. Phases of the moon.
7. Daily maxima of the number of the shocks.

In Prof. Michele Rossi's seismological observatory in Rome we saw at work a set of instruments devised by himself for registering both vertical and horizontal shocks. These are not the same as Palmieri's instruments, and are said to be more sensitive. In both sets of instruments the general principle is the same. The shock, by its movement, communicates motion to some appliance, such as a pendulum, or a column of mercury in a bent tube, which establishes electrical communication with a recording instrument. In the latter a ribbon of paper is drawn at a definite rate over a drum, and whenever electrical contact is established a small electro-magnet becomes active and draws down an armature to which a pen is attached, and for every contact a mark is made upon the

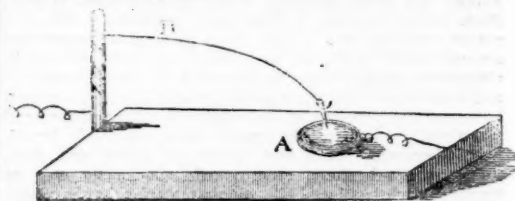
paper ribbon. The length of paper corresponding to an hour of time being known, it is easy to determine the instant at which the mark has been made, viz., the instant at which the shock has occurred.

Without any doubt the most interesting article in last year's *Bulletino* is that on the application of the microphone to the study of subterranean meteorology, by Prof. Michele de Rossi. In 1875 Count C. Mocenigo, of Vicenza, made an observation which was nothing less than the fundamental fact of the microphone, at a time when neither microphone, phonograph, nor micro-tasimeter had been invented. He observed that electric currents indicate perturbations and interruptions in a galvanometer by means of frictions and shocks produced artificially between conductors not in perfect contact ("per effetto soltanto di attriti e di scosse comunicate artificialmente ai conduttori posti fra loro in semplice contatto instabile"). He also observed that the same phenomena were produced by natural and unknown causes, when the apparatus had not received any artificial shock.<sup>1</sup> The account which he gave of his observations led Prof. de Rossi to conclude that these unknown perturbations arose from microseismic oscillations of the soil. He communicated his views to Count Mocenigo, who at once commenced to make experiments in the direction indicated, in the midst of which the news of the invention of the microphone in America, was received. Prof. de Rossi at once endeavoured to apply it to the detection of subterranean phenomena, and for this purpose he commenced a series of experiments in the seismic observatory which he has established at Rocca di Papa, one of the Alban Hills about seventeen miles from Rome. A special microphone consisting of a balanced pointed lever lightly touching a plate of silver, was mounted on a stone pedestal, and was placed twenty metres underground, at a distance from habitations and from roads. It was also thoroughly isolated and shut up in a box filled with wool. The instrument was watched during some of the stillest hours of the night, and the same mysterious sounds which Count Mocenigo had recognised were heard by de Rossi, which he considers were incontestably natural and intra-telluric. The sounds were carefully analysed, and were compared with artificially produced sounds. The microseismic sounds were speedily differentiated from other sounds, and their nature was completely confirmed when it was observed that they were often coincident with movements of the seismograph, and that they were of a periodic character. On one occasion, as de Rossi was listening at about half-past three o'clock in the morning the telephone connected with his subterranean microphone emitted sounds like the discharge of musketry, of such loudness that he feared they would awaken a child who slept in the same room, and he therefore disconnected the telephone. A short time afterwards, towards four o'clock, a sensible shock of earthquake occurred, for which the sounds had been the microphonic preparation.

In the beginning of last September Vesuvius showed many signs of an approaching eruption. During the night of the 22nd of that month the mountain produced thundering sounds, and at the same time loud metallic noises were heard in the microphone, more than a hundred miles distant. The microphone was soon afterwards transported to the observatory on Vesuvius, and it was then possible to trace the precise correspondence between the movements of the seismographs and the sounds of the microphone, and moreover to ascertain the seismic value (*il significato sismico*) of the different sounds of the microphone. It was also ascertained that if a watch were connected with the microphone, the noise of the tic-tac heard in the telephone became much louder just before a shock, and gradually less and less loud as the seismic

<sup>1</sup> "Fenomeni singolari di interferenza fra le correnti elettriche ed i promossi meccanicamente sul legno."—Bassano, 1875.

agitation died away. This led Prof. de Rossi to improve a microphone which he has found very useful for microseismic purposes.



A watch, A, is placed upon a suitable stand, and a thin copper wire, B, connected with the positive pole of a small battery is arranged, as shown in the figure, so that one end of it, furnished with a steel needle, rests lightly upon the smooth silver surface of the watch. The handle of the watch is connected by the wire with the telephone, the other binding screw of which is connected with the negative pole of the battery. Such an arrangement furnishes a very effective microphone, if the degree of contact between the needle and the surface of the watch be carefully regulated.

G. F. RODWELL

#### OUR ASTRONOMICAL COLUMN

THE OCCULTATION OF ANTARES, JULY 28.—The only occultation of a very conspicuous star during the present year which is visible in this country and in fact the only one higher than the second magnitude up to the year 1883, is that of Antares on the evening of July 28. It will take place at a low altitude here. As is well known Antares is a double star, and the effect of the duplicity was shown by observation of the occultation of the star by the moon, before the companion was detected by Mitchel at Cincinnati in July, 1845. The appearance of a comparatively faint star at emersion, suddenly brightening up to the full brilliancy of Antares, had been recorded, and a suspicion of duplicity entertained at least in one instance, some twenty years previous. Interest therefore attaches to the occultation of July 28, and with the view to facilitate the determination of the times of immersion or emersion at any place in this country, we will apply the Littrow-Woolhouse method of distributing the prediction of the phenomenon. Direct calculations give the following results for Greenwich, Edinburgh, and Dublin; the moon's place is corrected nearly to agree with Newcomb's theory:—

|            | Greenwich M.T.<br>of Immersion. | Angle from<br>N. Point. |  | Greenwich M.T.<br>of Emersion. | Angle from<br>N. Point. |
|------------|---------------------------------|-------------------------|--|--------------------------------|-------------------------|
|            | h. m.                           |                         |  | h. m.                          |                         |
| Greenwich. | 9 38'11 ...                     | 153'3                   |  | 10 7'03 ...                    | 200'2                   |
| Edinburgh. | 9 38'53 ...                     | 166'5                   |  | 9 49'93 ...                    | 184'9                   |
| Dublin ... | 9 33'05 ...                     | 161'4                   |  | 9 50'53 ...                    | 189'0                   |

From which, putting the latitude of the place =  $50^\circ + L$  ( $L$  in degrees), and the longitude in minutes of time =  $M$  (+ if east, - if west of Greenwich), we find—

$$\begin{aligned} \text{G.M.T. of Immersion} &= 9\ 36'86 + 0'841 L + 0'263 M \\ \text{Emersion} &= 10\ 10'74 - 2'507 L + 0'462 M \end{aligned}$$

$$\begin{aligned} \text{Angle from N. Point at Immersion} &= 149'4 + 2'6 L - 0'1 M \\ \text{Emersion} &= 204'2 - 2'7 L + 0'2 M \end{aligned}$$

These formulæ give for—

|               | Immersion. | Angle. | Emersion.  | Angle. |
|---------------|------------|--------|------------|--------|
|               | h. m.      |        | h. m.      |        |
| Cambridge ... | 9 38'7 ... | 155    | 10 5'2 ... | 198    |
| Oxford ...    | 9 37'0 ... | 155    | 10 4'0 ... | 198    |
| Liverpool ... | 9 36'5 ... | 160    | 9 56'5 ... | 192    |

Which are Greenwich mean times; the angles are reckoned as is usual in the occultation-predictions of the *Nautical Almanac*, for the inverted image. At Greenwich

the altitude of the star at emersion will be  $74^{\circ}$ , and at Edinburgh  $54^{\circ}$ .

Suppose, for the sake of an example of the application of the above formulae, it is desired to know the Greenwich mean times of immersion and emersion of Antares as viewed from Brighton, which place we will assume to be in latitude  $50^{\circ} 50'$  and longitude  $0^{\circ} 32'$  west of Greenwich. We have then  $L = +0^{\circ} 83'$ , and  $M = -0^{\circ} 53'm$ ; it will be sufficient to include the second decimal only in the factors for  $L$  and  $M$  in the formulae:—

For the immersion—

$$\begin{aligned} (+0^{\circ} 83') \times (+0^{\circ} 84') &= +0^{\circ} 70' \\ (-0^{\circ} 53') \times (+0^{\circ} 26') &= -0^{\circ} 14' \end{aligned} \quad \begin{array}{l} \text{The sum } +0^{\circ} 56'm, \text{ added to} \\ \text{9h. } 36^m.86m., \text{ gives 9h. } 37^m.4m. \\ \text{for G.M.T.} \end{array}$$

For the emersion—

$$\begin{aligned} (+0^{\circ} 83') \times (-2^{\circ} 51') &= -2^{\circ} 08' \\ (-0^{\circ} 53') \times (+0^{\circ} 46') &= -0^{\circ} 24' \end{aligned} \quad \begin{array}{l} \text{The sum } -2^{\circ} 32'm, \text{ added to} \\ \text{10h. } 10^m.74m., \text{ gives 10h. } 8^m.4m. \\ \text{for G.M.T.} \end{array}$$

Similarly the angles will be found to be  $152^{\circ}$  at immersion and  $202^{\circ}$  at emersion.

The companion of Antares preceding the principal star nearly on the parallel will emerge several seconds earlier.

THE GREAT COMET OF 1874.—Just five years since, as we write, the comet discovered by M. Coggia at the Observatory of Marseilles on April 17, 1874, was beginning to attract general attention as a naked-eye object in the evening sky. The orbit, the determination of which presented some difficulty at first, from the slow motion of the comet, had been ascertained with sufficient precision to enable astronomers to predict its conspicuous appearance in the first half of July, and the track it would follow when, descending below the horizon in Europe, it became a favourably-situated object for the observatories of the other hemisphere. It was observed in Europe until July 16, and about a week later was seen in Australia; observations were continued till October, the last being made at the Argentine Observatory, Cordoba, on the 18th of that month, when it had receded to a distance of  $1.94$  from the sun and  $1.79$  from the earth, and was situate about  $12^{\circ}$  from the south pole of the heavens.

The European observations during three months were found to indicate a sensible, though not very material deviation of the orbit from a parabola, and ellipses were calculated at the time by Tietjen, Schulhof, and Geelmuyden. In a late number of the *Astronomische Nachrichten* are elliptical elements founded by M. Seyboth, of Riga, upon the meridian observations made at Moscow, which appear to possess a very high degree of precision, though they extend over an interval of twenty-six days only. The periods of revolution assigned by these computers are:—

|            |     |     |     |              |
|------------|-----|-----|-----|--------------|
| Tietjen    | ... | ... | ... | 8,965 years. |
| Schulhof   | ... | ... | ... | 12,184 "     |
| Geelmuyden | ... | ... | ... | 10,445 "     |
| Seyboth    | ... | ... | ... | 5,711 "      |

The differences between these periods show that beyond establishing the fact that the comet was moving in an orbit with a period of revolution extending to several thousand years, no reliable approximation to its true length has yet been obtained, but the additional three months' observations in the southern hemisphere have not hitherto been brought to bear upon the determination of the elements. The last Cordoba observations give the following final position:—

1874, October 18, at  $14^h. 46^m. 58s.$  G.M.T.

|                          |     |     |     |                        |
|--------------------------|-----|-----|-----|------------------------|
| Apparent Right Ascension | ... | ... | ... | $99^{\circ} 46' 27''$  |
| " Declination            | ... | ... | ... | $-77^{\circ} 42' 36''$ |

If we compare the elements of Geelmuyden and Seyboth with this observation, taking aberration into account, we find the following differences:—

Error in R.A.

Error in Decl.

|            |     |     |     |       |     |     |       |
|------------|-----|-----|-----|-------|-----|-----|-------|
| Geelmuyden | ... | ... | ... | $+31$ | ... | ... | $+65$ |
| Seyboth    | ... | ... | ... | $+59$ | ... | ... | $+99$ |

so that while, as tested by this single observation, the longer period of revolution appears to have the advantage, it is sufficiently evident that ellipses with divergent periods may eventually be found to represent the observations with almost equal precision, or in other words the length of the revolution will remain open to considerable uncertainty. If the deviation of the form of the orbit from the parabola, which satisfies the motions of the majority of comets be due to planetary attraction, we might look to Venus as the agent, since at the descending node the comet in 1874 approached the orbit of that planet within 300,000 miles ( $0.00325$  of the earth's mean distance); the opposite node falls at a radius-vector of  $11.65$ . The aphelion distance, according to Geelmuyden's calculation would be  $95.5$ , or the comet would have travelled to these parts of space from a distance exceeding by more than thirty times the mean distance of Neptune.

### GEOGRAPHICAL NOTES

THE Abbé Debaize, who by previous accounts was at Igonda on March 20, seven days' journey from Ujiji, has written under date of April 2 from the latter place to the director of the Paris Observatory and others, giving a brief sketch of his immediate plans. He proposes to take all his porters and merchandise by water to the Uzighé country at the north end of Lake Tanganyika, and to form a dépôt there, which he will leave in charge of some of his best men; he will then establish a second dépôt at the mouth of the Aruwimi, the great northern tributary of the Congo. Afterwards, starting in light marching order, he hopes to be able to explore the western slopes of the Blue Mountains, the countries situated between the southern end of Albert Nyanza and Lake Tanganyika, and especially Unyambongu, Mpororo, and Ruanda. He will then return to his dépôt in Uzighé, whence he will send home an account of his discoveries, as well as a statement of his future plans.

AN interesting and extremely well written pamphlet has just appeared in the "Sammlung gemeinverständlicher wissenschaftlicher Vorträge," edited by Prof. Virchow and Herr von Holtzendorff. Its title is "Die Tiefsee und ihre Boden und Temperatur Verhältnisse," its author Dr. Georg von Boguslawski, the well-known editor of the *Annalen der Hydrographie* at the Imperial Admiralty of Berlin. The writer first gives a clear and concise account of all expeditions sent out by various countries for the investigation of the depths of the sea, particularly those of the *Gazelle*, the *Challenger*, and the *Tuscarora*. He then enters at greater length upon a discussion of the results obtained hitherto, treating first of the depths themselves, then of the outlines and physical condition of the sea-bottom, and finally of the distribution of temperatures and the inter-oceanic currents, with their causes and effects. Our space does not permit us to enter into details at greater length, suffice it to say that the little work is a welcome and valuable addition to scientific literature.

THE Geographical Department of the Japanese Government, which is displaying considerable activity in many directions, has commenced the publication in sheets of a large plan of the city of Yedo, showing the various divisions, streets, bridges, &c., and giving the names in Japanese and Roman characters.

UNDER the title of "Voyage d'Exploration dans l'Intérieur des Guyanes," the *Tour du Monde* has commenced the publication of Dr. Jules Crevaux' account of his journey in 1876-7 through French Guiana and across the Tumac Humac range to the Amazons. The illustrations are very interesting and well executed, and there is also a sketch map of the region.

THE *Annalen der Hydrographie*, Heft v., contains an important article on the Movement of Water in Rivers, based on river observations at various depths of water, made at the lightship station on the Genius Bank, in the Jade, from October 17 to December 10, 1878.

M. GUSTAVE MOYNIER, as Director, and M. Ch. Faure, as Editor, announce the publication of a new geographical journal—*L'Afrique*—entirely devoted to Africa. It is proposed to embrace in it the gist of all that is important published anywhere relating to the continent with which the journal deals. It will be published monthly by M. Jules Sandoz, Geneva, the size being sixteen pages octavo.

AN *Annuaire des Sociétés de Géographie* will shortly be published in Paris.

WE learn from *Vanity Fair* that a party, of which Lady Florence Dixie was the only lady, has just returned from South America, where they "crossed many hundreds of miles of the wild and unexplored pampas of Patagonia, penetrating amidst the Cordilleras into splendid scenes hitherto unexplored and unseen by man."

THE *Bulletins* of a number of foreign societies are to hand. The new number of the *Bulletin* of the Lyons Geographical Society contains, besides the annual report, the conclusion of M. Luciano Cordeiro's chapters on the first explorations of Central Africa and the Portuguese doctrine of African hydrography in the fifteenth century, and the first part of an essay on Central Asia, by Col. Debize. In this number he deals with Eastern Turkestan, illustrating his remarks with a sketch map of North-Western China and Kashgaria.—The last number of the *Bulletin* of the Société de Géographie Commerciale of Bordeaux contains a second paper on the subject of the commercial exploration of Ferlo, an almost wholly unknown region of Senegambia.—The May number of the *Bollettino* of the Italian Geographical Society contains a learned and able lecture by Prof. Marinelli, on Scientific Geography, in which he traces the progress of this department, and shows how comprehensive and important it is.—The last number of the *Bulletin* of the American Geographical Society (No. 2 of 1879) contains a paper by Major A. G. Constable on Afghanistan. Major Constable served in the English army in the former Afghan war.—The May number of the *Bulletin* of the Paris Geographical Society contains a full report of the proceedings at the recent Cook Centenary in Paris, including a descriptive catalogue, by Dr. Hamy, of the articles exhibited during the celebration, and the cartography and bibliography of Cook's voyages, by Mr. James Jackson. An accompanying map shows the routes followed by the English navigator in his various voyages.

#### NOTES

FOR the fine plate of tubes in this week's number, illustrating the paper by Messrs. De La Rue and Müller, as well as for the numerous woodcuts, we are indebted to the liberality of Dr. De La Rue.

It is gratifying to find foreign governments and societies so ready to show their appreciation of our eminent scientific workers. Last week we announced the election of Prof. Huxley as a Corresponding Member of the Paris Academy of Sciences, and now we have to chronicle a double honour just received by Prof. Stokes of Cambridge: the Emperor of Germany has conferred upon him the Order "Pour le Mérite," and the Paris Academy have elected him a Corresponding Member in the section of Physics in place of the late Prof. Ångström.

DR. DONDERS has been elected in the section of Medicine and Surgery in the same Academy, to succeed the late Prof. Ehrmann.

THE candidates whose names we have already given were elected Fellows at last Thursday's meeting of the Royal Society.

PROF. SIR C. WYVILLE THOMSON was last week compelled, from sudden indisposition, to relinquish his course of lectures at the University of Edinburgh. We are glad to be able to announce that he is now completely recovered. His medical attendants, however, deem it prudent that he should abstain from lecturing again this session. His large class of between 400 and 500 students has accordingly been entrusted to Prof. Alleyne Nicholson, of St. Andrews, who will conduct it during the remainder of the session. Though dissuaded from undertaking the heavy duties of his college work, Sir Wyville, we hope, will find strength to resume his labours amid the *Challenger* materials, so that this great work, for which the world is very patiently waiting, may suffer no serious delay.

PROF. WURTZ, the eminent French chemist, has been appointed a Member of the Council of the Legion of Honour.

THE arrangements for the annual meetings of the principal foreign associations are announced. The German Anthropological Society holds its yearly meeting at Strassburg on August 11, 12, and 13, and the fifty-second meeting of the German Association of Naturalists and Physicians will be held at Baden-Baden from September 18 to 24. The French Association for the Advancement of Science will hold its eighth session at Montpellier, commencing on August 28. The president is M. Bardoux, late Minister of Public Instruction. Applications are to be addressed to 76, Rue de Rennes, Paris. The American Association meets this year at Saratoga, on August 27, the President being Mr. George F. Barker, of Philadelphia.

EARTHQUAKES would seem to be plentiful and wide-spread at present. A Reuter's telegram, of date Messina, June 17, states that continual shocks of earthquake, attributed to the volcanic action of Mount Etna, have occurred in the neighbourhood of Santa Venere and Guardia, causing serious damage and considerable loss of life. Vesuvius is stated to be showing signs of activity. A distinct shock of earthquake is reported to have been felt on Monday at Tobermory, and other places in Mull, in the Hebrides. The shock passed from north-east to south-west. On the 7th inst. an earthquake of short duration was observed at Versailles at 10.55 P.M. There was a severe shock of earthquake in Costa Rica on the night of May 29. The cathedral and many of the principal buildings of San José were shattered, and much damage was done in other parts of the republic.

DR. J. C. DRAPER is at present in this country. He has been extending his researches on oxygen in the sun (see *NATURE*, vol. xix. p. 352), and has read papers on the subject at the Astronomical and Physical Societies.

WE regret to announce the death of Dr. Karl Neubauer, the eminent German chemist. Dr. Neubauer died on the night of June 1-2 at Wiesbaden, where for many years he had been working in the laboratory of Dr. Fresenius. The death is also announced of Dr. Justus Ulrich, Professor of Mathematics at Göttingen University, who died on May 30.

THE Committee on Electric Lighting, recently appointed by the House of Commons, have finished hearing evidence, and issued their Report, which is in substance as follows:—"That sufficient progress has been made with electricity as a means of lighting to encourage the belief that it has an important future before it, and not only for illuminating purposes, but as a source of power which may be wisely distributed and applied to mechanical purposes. The committee are of opinion that the electric light, even in its present state of development, can be advantageously used in large areas, open or inclosed, such as large halls, squares, or railway stations; but they do not think it has been so far matured as to be able to compete with gas for

domestic purposes. They therefore do not recommend any legislation for applying the light to private purposes on the strength of its being practicable for large spaces and buildings, but they do recommend that no legislative restrictions shall be allowed to impede its further development. As to granting authority for adopting the electric light, the committee think there is already in existence sufficient power for applying it to open spaces and large centres; and, mentioning the diversity of views among the witnesses as to whether or not municipal bodies have power under existing statutes to break up streets for the purpose of laying electric light wires, they say that if such power does not exist it should be granted under proper regulations. They consider, however, that the time is not yet ripe for allowing private companies to break up streets in order to supply the electric light, but they advise that municipal authorities should receive all possible help for public lighting by electricity, and that the Legislature should be willing to give all reasonable facilities for extending the use of the electric light where proper demand for it arises. They consider further that for lighthouse purposes the electric light has established itself, but they have not been able to satisfy themselves from the evidence that electric lighting is economical as compared with gas.

The success of the Jablochkoff lights at the Palais de l'Industrie is nightly increasing. The number of visitors exceeds 6,000 nightly, exclusive of press men, artists, and bearers of free tickets. The salons are rather more crowded than in daylight. No extinction at all has been noticed since the first night. The change of candles is effected by keys worked from the engine-house, and takes less than a second for each series of lamps. Several places of public entertainment in Paris are adopting the Jablochkoff light principally to avoid the heat which results from burning gas, and is so obnoxious in summer time.

As an illustration of the combination of science and commerce we may mention a new idea that has lately been carried out by a Swiss firm of chocolate-makers. We are unable to say whether the chocolate *bon-bons* have any peculiar merit in themselves, but the attraction lies in the manner of packing, the sweetmeats being put up in boxes containing two layers of small packets put up in very ornamental wrappers with coloured designs, in series representing the various branches of natural history, such as birds, butterflies, fishes, fruits, flowers, and even palæontology and geography. Each box, containing about twenty small packets of chocolate, is accompanied with a concise descriptive treatise in French written by a competent naturalist. That on birds is thus described:—"After a pleasant general introduction on the utility and charming attraction of birds, and the necessity for the protection and preservation of many, a brief sketch is given of their properties of flight, structure, organs of sense, sight, smell, and voice, respiration, nests, eggs, and incubation, moulting, geographical distribution, migration, utility to man, and general classification. Instructions are also given for preparing and mounting bird-skins, and scientific descriptions are furnished of those birds chosen for illustration either for their beauty or brilliant plumage." A similar plan to the above is adopted in other branches of natural history.

HARTLEBEN of Vienna announces the publication of an Illustrated History of Writing, a popular account of the origin of writing, of speech, and of numbers, as well as the systems of writing of all peoples. The author is Herr Karl Faulmann. The work will be illustrated with numerous coloured plates as well as woodcuts.

THE *Patriot* of Angers relates that on June 10 an immense number of butterflies were observed flying above a part of the city called Le Mail. They were travelling at a little distance from the earth, and inconveniencing persons walking in the streets. The same phenomenon was observed in Alsace, at

Bisheim, on the 8th. The Bisheim butterflies were so numerous, according to the *Journal d'Alsace*, that the light of day was obscured. Their colour was red, in places tinged with grey. On the 7th the commune of Wetzikon, in the canton of Zurich, was invaded by an immense swarm of butterflies a kilometre wide, and so long that the procession took two hours to pass. They flew from two to ten metres above the ground, and went off in a north-westerly direction. Swarms of grasshoppers have recently appeared in Armenia. News from Elisabetpol states that both the banks of the River Kur were completely covered with the insects, as far as Terter on the one bank, and as far as Akstafa on the other. All vegetation is devastated.

The *North German Gazette* states that a woman in the neighbourhood of Düsseldorf, who had been bitten by a mad dog, has been cured by Dr. Offenbergh, by an injection under the skin of a dose of twenty centigrammes of curare.

THE village of Mariaweller near Düren (Rhenish Prussia) proves to be a great field of *debris* of a Roman colony. A Roman villa has just been excavated there so that most of the apartments could be measured. An inscription in one of the rooms has not yet been deciphered. The Roman coins found at the place date down to the fourth century.

FOSSIL remains of a mastodonte have just been found in Vienna on the Ottakringer Strasse. Prof. von Hochstetter himself undertook the excavation of the remains. With the exception of the jaw and teeth all the bones found are much decomposed, and it will be very difficult to preserve them.

A GENEVA correspondent writes that a meteor of remarkable brightness and size was seen on June 7, about 10 P.M., in the neighbourhood of that city. It was also seen at Neuchâtel, Zug, Milan, and over its entire course its path was sinuous, presenting a strange zig-zag form. Some who saw it speak of it as having the appearance of the full moon, giving out an iridescent or greenish light. Its path was from north-east to south-west. The meteor, according to the *Times* Geneva correspondent, was seen in several other parts of the Confederation and at St. Vittore Olona, in Lombardy. Four minutes after it finally disappeared, he states, there was heard a loud report, resembling a volley of artillery. A similar report was heard in the Valaisian Alps, and almost at the same time, according to the *Gazette de Lausanne*, a shower of *aérolites* fell into Lake Lugano, near Melide, causing violent undulations, and nearly overturning the boats of several fishermen who were returning to port.

ON Friday last a first trial was made at Woolwich of the new 100-ton gun. The shot with which it was loaded weighed 2,010 lbs. The gun was fitted with a gas check. Its diameter was very little less than that of the bore, which has a calibre of 17½ inches, increasing to 19½ inches in the powder chamber. The thickness of the metal at the muzzle is about 5 inches only, but at the breech-end the chamber is surrounded with a wall of iron 2 feet 5 inch through, making the maximum diameter 6 feet 6 inches. The gun is 36 feet in length, of which the bore occupies 33 feet, and the total length of gun and carriage when run out for firing is 44 feet. The cartridge, consisting of 440 lbs. of cube powder, strongly bound in canvas and stiffened by wooden bands, was rammed home, occupying 5 feet of the bore, and then followed the projectile, the length of which was 2 feet 8 inches. The gun was fired by electricity from the instrument-room, and recoiled a considerable way up the platform, but suffered no damage either to itself or the carriage. The screens registered a velocity of 1,590 feet per second, but the projectile was found to have broken up, which may have affected the result.

THE Mayor of Liverpool has given to the Council of the Iron and Steel Institute an invitation to visit that town in September, and a deputation from the Council of the Institute waited upon

the Mayor at the Buckingham Palace Hotel on Saturday, when they discussed with him the preliminary arrangements and provisionally fixed September 24, 25, and 26 for the meeting, which will be the first held by the Institute in that town.

In the annual report of the Deputy Master of the Mint, issued last week, we find some remarks on several points of scientific interest more or less intimately connected with the work of minting. Among these may be mentioned the adjustment of blanks by electrolytic agency, to which attention had been directed in former years. The process, originally advocated by Mr. Roberts, the chemist of the Mint, has already been employed on a large scale in the Indian Mint. The question of the change in the density of a metal by annealing is one of some importance in the operations of minting. The experiments commenced in 1877 showed that the effect of even moderate temperatures was appreciable, and the results of their continuation are given by Mr. Roberts. In connection with this subject, Mr. Fremantle remarks that it is interesting to turn to such experiments of M. Tresca on the flow of solids as have special reference to mint work, and to those which have been undertaken in the English Mint on the flow of molten metals through capillary tubes. It is hoped that the latter may ultimately throw light on the phenomenon of liquation.

THE *conversazione* of the Society of Arts will be held in the South Kensington Museum on June 25.

THE members of the International Telegraphic Conference were entertained at dinner on Monday night, and last night a *conversazione* was held in connection with the Conference. The labours of the Conference have been chiefly administrative and financial.

We learn from the *Colonies and India* that rich deposits of gold have been discovered in various parts of Nova Scotia, where its existence has hitherto been hardly suspected. The most important discovery made has been near Bannockburn, in the township of Madoc, where a large nugget of gold of fine quality was recently found, and an extensive gold field is being opened out. Coal and iron are also plentiful in the province.

THE additions to the Zoological Society's Gardens during the past week include an Indian Antelope (*Antelope cervicapra*) from India, presented by the Hon. A. Greville, 60th Rifles; a White-whiskered Paradoxure (*Paradoxurus leucomystax*) from the East Indies, presented by Mr. Carl Bock; two Common Paradoxures (*Paradoxurus typus*) from India, presented by Mr. G. Bradbury; a Common Magpie (*Pica caudata*), British Isles, presented by Mr. J. Loraine Baldwin, F.Z.S.; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. E. Hawkins; a Tuberculated Lizard (*Iguana tuberculata*) from the West Indies, presented by Dr. A. Stradling; a Caspian Ouaran (*Psammisaurus caspius*) from Persia, presented by Commander J. Pratt, s.s. *Java*; a West African Python (*Python sebae*) from West Africa, presented by Mr. G. H. Garrett; five Climbing Anabases (*Anabas scandens*) from India, presented by Mr. A. F. Dobson; a Tamandua Anteater (*Tamandua tetradactyla*), a Sun Bittern (*Eurypyga helias*) from South America, a Black-eared Marmoset (*Hapale penicillata*), a Brazilian Cariama (*Cariama cristata*) from South-east Brazil; a Crested Screamer (*Chauna chevaria*) from Buenos Ayres, a Daubenton's Curassow (*Crax daubentoni*) from Venezuela, a Negro Tamarin (*Midas ursulus*) from Guiana, a Spotted-billed Toucanet (*Selenidera maculirostris*), three Violet Tanagers (*Euphonia violacea*), two Saffron Finches (*Sycalis flaveola*), a Pileated Finch (*Coryphospingus pileatus*) from Brazil, a Great American Egret (*Ardea egretta*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, deposited; a Black Hornbill (*Buceros atratus*) from West Africa, a Green-winged Trumpeter (*Pipha viridis*) from Brazil, a Common

Crowned Pigeon (*Goura coronata*) from New Guinea, two Orinoco Geese (*Chenalopex jubata*) from South America, six Melodious Finches (*Phonipara canora*) from Cuba, purchased; two Geoffroy's Doves (*Peristera geoffroyi*), two Yellow-legged Herring Gulls (*Larus leucophaeus*) bred in the Gardens.

### THE RECENT HONORARY DEGREES AT CAMBRIDGE

IT may interest our readers to see the terms in which the Public Orator of Cambridge University spoke of the eminent men of science on whom the degree of LL.D. was conferred on June 10, as we announced last week. Mr. Sandys spoke as follows of Sir William R. Grove:—

Iuris initium a natura esse ductum auctore Tullio accepimus; iuris peritiam summam cum intima rerum naturae cognitione esse consentaneam, non modo Baconis nostri exemplo confirmatum est, sed huius quoque iudicis auctoritate defenditur. Magnum profecto rerum naturae amorem testatur oratio illa, qua tredecim abhinc annos societatis Britannicae scientiarum finibus proferendis annui praesidis munus auspicatus, in universa rerum natura ordinem quandam serie perpetua continuatum inesse docebat; testatur oratio illa altera plusquam triginta abhinc annos primum edita, qua primus indicavit lucem, calorem, vim electricam, vim magneticam, mutuum rerum quae dicitur affinitatem, ipsum denique motum, omnes alium ex alio posse generari, omnes necessitudine quadam inter se aptos et connexos esse, "ostendens" (ut Lucreti verbis utar)

corpuscula materiali  
ex infinito summam rerum usque tenere  
undique protelo plagarum continuato.

Quod si ipse continuo tenore totam tanti ingeni vim rerum naturae cognoscendae intendisset; ille profecto qui luci electricae novum splendorem addidit, talium rerum obscuritati etiam maiorem lucem attulisset. Ceterum ille qui non modo legum scientiam sed scientiarum quoque leges optime interpretatus est, iure optimo legum doctor hodie creabitur; duplicis palmae laudem meritis, vestro omnium plausu iure excipietur Wilelmus Robertus Grove.

In introducing Dr. William Spottiswoode the Public Orator said:—

Societatis Britannicae scientiarum finibus proferendis praeses ille quem Regiae quoque Societatis praesidem hodie salutamus, fines quam amplius mathematicorum regno assignaverit, meminit omnes qui anno proximo orationem illam Dublinensem audivistis. Imperium neque temporis neque spatii finibus terminatum illis dedit quos nonnumquam iuvat quasi oceani infiniti propter litora calculos numerare, nonnumquam in purum illud caelum, regionem illam inexplicabilem evolare, ubi spatium multiplex extenditur, ubi nodi tantum abest ut solvi ut ne necti quidem possint. Ipse ne Europae quidem philosophorum finibus contentus, Indorum quoque doctrinam mathematicam et antiquam linguam sacram exploravit; Asiae et Europae confinia bis lustravit, lustrata litteris mandavit. Populi in usum, ordine quam lucido lucis et coloris leges ipse illustravit; quot aliorum libros e prelo suo regio in lucem emisit, et sua et nostra cum Academia privilegiorum communium iure adhuc aliquatenus coniunctus; quanta denique liberalitate, et ministrorum suorum et populi universi liberaliter educandorum causa, pro virili parte laboravit. Ut viro integerrimo, titulis plurimis aliande cumulo, nostri quoque tituli mantissa accedat, duco ad vos Wilelmum Spottiswoode.

Of Prof. H. J. S. Smith he said:—

Pariter iniquum esse existimavit Aristoteles ab oratore rerum omnium rationes accuratas exigere, atque mathematicum ad persudandum apposite dicentem tolerare. Atqui ipse exemplar egregium μαθηματικῶν τριβαρολογητόρων libenter admiratus esset, si in senatu Oxoniensi flumen orationis aureum fundentem hunc geometriae professorem audire potuisset, qui nomine duplici, et linguarum antiquarum et scientiarum mathematicarum peritia, cathedra illa dignus est quam Savilius ille, et Chrysostomi editor et interpres Euclidis, primus occupavit, occupatam annuo reddito in perpetuum ornavit. Tertiū quidem ordinis linearem enumerationem Newtonus ille noster olim Latine conscripsit, hic autem, quarti ordinis lineis eadem lingua descriptis, et certamine toti Europae ab Academia Berolinensi proposito, duplicis palmae particeps discessit. Quanta igitur spe et expectatione libros illos de recentiore quae dicitur geometria, de subtilioribus numerorum

proprietas, plusquam Horatianum annorum numerum huius intra scrinia clausos, iamdudum flagitamus; quos, uti par est omnibus numeris absolutos, aliquando prodituros esse speramus. Interim in negotiis Academicis singulari urbanitate diu versatus, nunc non modo collegio augurum Britannicorum qui cæli præcæcia observant præsidet, sed septemviris quoque Academiae Oxoniensi legibus conscribendis ascriptus est. Academiae illius pulcherrimæ inter decora diu numeretur, diu Platonis præcepto obsecutus videat ut *οὐ τῇ καλλιπλείᾳ* geometriam nequaquam neglegant. Ducto ad vos Henricum Stephen Smith.

Of Prof. Huxley the Orator spoke thus:—

Academii inter silvas qui verum quaerunt, non modo ipsi veritatis lumine vitam hanc umbratilem illustrare conantur, sed illustrissimum quemque veritatis investigatorem aliunde delatum ea qua par est comitate excipiunt. Adest vir cui in veritate exploranda ampla sane provincia contigit, qui sive in animantium sive in arborum et herbarum genere quicquid vivit investigat, ipsum illud vivere quid sit, quali ex origine natus sit; qui exquirat quæ cognitionis necessitudo, inter priores illas viventium species et has quæ etiam nunc supersunt, intercedat. Olim in oceano Australi, ubi rectis "oculis monstra natantia" vidit, victoriam prope primam, velut alter Perseus, a Medusa reportavit; varias deinceps animantium formas quasi ab ipsa Gorgone in saxum veras sagacitate singulari explicavit; vitæ denique universæ explorandæ vitam suam totam dedicavit. Physicorum inter principes diu honoratus, idem (ut verbum mutemur a Cartesio illo cuius laudes ipse in hac urbe quondam prædicavit) etiam "metaphysica" honore debito prosecutus est. Illum demum liberaliter educatum esse existimat qui cum ceteris animi et corporis dotibus instructus sit, tum præsertim quicquid turpe sit oderit, quicquid sive in arte sive in rerum natura pulchrum sit diligit; neque tamen ipse (ut ait Aristoteles) "animalium parum pulchrum contemplationem fastidio puerili reformidat," sed in perpetua animantium serie hominis vestigia perscrutari conatus, satis ampla liberalitate in universa rerum natura "humani nihil a se alienum putat." Ducto ad vos virum intrepidum, facundum, propositi tenacem, Thomam Henricum Huxley.

Finally, among the scientific men who were honoured with the degree was Mr. H. C. Sorby, of whom the Public Orator said:—

Quam magna est rerum natura, in magnis quam immensa, in minimis quam magna. Quam multa miracula, antiquis ignota, illis nuper ostendi qui minuta curiositate arcana illa quæ oculorum aciem fugiunt, instrumentorum novorum auxilio perscrutantur. Hic autem ille est qui, et terrestrium et de cælo delapsorum lapidum investigandis elementis primis, primus inter Britannos talium instrumentorum usum accommodavit. Nuper societatis geologicæ præses electus, annorum triginta labores oratione cumulavit in qua vere marmoreum sibi monumentum exegit. Illud vero acutissimum quod crystallis etiam minutissimis exploratis in quibus (ut fit) pars altera est aquæ plena, altera aëris quoque vacua, olim indicavit qua potissimum calor temperie inclusa illa aqua totum illud vacuum implere, quo potissimum rerum statu saxum illud, quondam ignibus prorsus liquidum, primum durescere potuisset. Scilicet crystallum illud (ut Clandianus ait)

non potuit toto mehtiri corpore gemmam;  
sed medio mansit proditor orbe latex.  
auctus honos; liquidi crescent miracula saxi  
et conservatæ plus meruit aquæ.

Suo phaselo vectus quot maria mox lustrabit, in terra iam pridem unum saltem Argonautarum, qui terram oculis penetrabat, catenus æmulatus, quod in intima saxorum materia perspicenda, ipse oculo potuit "quantum contendere Lynceus." Ducto ad vos Henricum Clifton Sorby.

#### UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Clothworkers' Company have voted 3,500*l.*, over and above 10,000*l.*, previously voted, to cover the complete cost of the site, building, furnishing, and fitting with all necessary appliances the textile industries and dyeing instruction departments at the Yorkshire College, Leeds, and they have further agreed to maintain the building and its operations in full effect without extraneous or adventitious aid, for a period of five years as from January 1 next, at a cost of 1,200*l.* per annum. This increased annual subvention has been necessitated by the addition of instruction in dyeing and applied chemistry connected with the

finishing of textile fabrics. The new buildings will be completed about October next.

THE following awards for proficiency in Natural Science have been made at St. John's College, Cambridge:—Foundation Scholarships to W. A. Forbes, Fleming, Hart; a Proper Sizarship to Samways; Exhibitions to Lister, Samways, Stuart (already scholar), and Weldon. Forbes received also a Wright's Prize and augmentation of the year's emoluments to 100*l.* The Open Exhibition was awarded at Easter to Edmunds (University College, London), and a Second Exhibition to T. Roberts (University College, Aberystwith).

THE amended report of the Cambridge Botanic Garden Syndicate has been confirmed so far as relates to the stipend of the curator, which is fixed at 150*l.*, he not to take private pupils, and to be allowed 25*l.* per annum for the rent of a house until one is provided in the garden.

PROBABLY the oldest teacher in existence is the venerable M. Chevreul. This eminent chemist, who is about ninety years of age, has been advertised as lecturer on chemistry in the Paris Museum. The first part of his lectures will be devoted to the subject of contrast of colours. M. Chevreul enjoys excellent health, and exhibits admirable bodily as well as mental activity.

THE fourth centenary of the foundation of the University of Copenhagen was celebrated in that city on the 4th inst. No less than 4,000 people took part in the celebration, including the Royal family and all the highest civic and military authorities. The festive address was delivered by the Rector Magnus, Dr. Madvig.

#### SCIENTIFIC SERIALS

*Bulletin de l'Académie Royale de Belgique*, No. 4.—Besides communications on the blood of the lobster (Fredericq), displacement of spectral lines of stars (Spee), and perpetual motion (Plateau), we have here a paper by M. Fredericq on the theory of respiratory innervation; he is led to regard the spinal cord as containing an inspiratory centre and an expiratory centre, chloral acting to paralyse the former.—M. van der Mensbrugghe contributes a paper on new applications of the potential energy of liquid surfaces, dealing with the principal cause of loss of charge by water-jets, origin of the energy of motion acquired by waves of the sea, cause of production of bars at the mouths of certain rivers, and origin of the force of the Gulf Stream.—M. De Selys Longchamps communicates the additions to the synopsis of the Calopterygines.

*Atti della R. Accademia dei Lincei*, April.—We note here the following:—Influence of boric acid on acetic fermentation, by Prof. Herzen.—Distribution of subsoil water in the Agro Romano, and its influence in production of malaria, by S. Tommasi-Crudeli.—On giant-cauldrons, by S. Botti.—Geological studies on the northern Graian Alps, Italian side, by Prof. Baretta.—On the supposed identity of columbine with limonine, by SS. Paterno and Ogialoro.—On the kinzigite of Calabria, by Prof. Lovisato.—New rock-specimens from Calabria, and remarks on the serpentine formation of that region, by the same.—On the geodetic line; third general problem; analysis of spheroidal triangles, by Dr. Wurterberg.—On observations of the horizontal diameter of the sun, made at the Royal Observatory of the Campidoglio in 1878, by S. Respighi.—Catalogue of algae gathered during the cruise of the cutter *Violante*, and especially in some small islands of the Mediterranean, by S. Ficcone.—On the motion of a simple pendulum in a railway carriage, by S. di Saint-Robert.—On the difficulty of obtaining sulphuric acid perfectly free from arsenic, on the mode of obtaining it, and on some things relating to arsenic, by S. Selmi.—On the miocene strata of Siena, and considerations on the upper miocene.—On the crystalline form of anglesite of Sardinia, by S. Sella.—Obituary notice of Volpicelli, with list of published works.

*Journal of the Franklin Institute*, May.—Limit of efficiency in heat-engines, by Prof. Thurston.—The driving-power of leathern belts, by Mr. Cooper.—On the initial effect of the earth's rotation on the free pendulum, by Prof. Tobin.—On the measurement of tidal heights, by Mr. d'Auria.

THE *Verhandlungen des Vereins für naturwissenschaftliche Unterhaltung zu Hamburg* (vol. iii. 1876) contain, amongst other less important ones, the following papers:—On the manners and customs of the Hamran tribe, by M. Eckardt.—On the

myths and songs from the South Pacific, by Dr. C. Crüger.—On the metamorphosis of amphibia, by Dr. J. W. Spengel.—Some diagnoses of new Heteromera, by Dr. Haag-Rutenberg.—Descriptions of some new butterflies from the Philippine Islands, by G. Semper.—On the species of the butterfly-genus *Zethenia*, by the same.—On butterflies from Wladivostock and from the Gaboon River, by Dr. C. Crüger.—On dimorphism and variations of some North American butterflies, by J. Boll.—On the metamorphosis of *Sepdon*, by G. Gerecke.—On *Helix alonensis*, Fer., by H. Strebel.—Note on the geography of molluscs, by J. D. E. Schmeltz.—On the miocene formation of Reinbeck and its mollusc fauna, by Carl Gottsche.—On the geological conditions of the neighbourhood of Kiel, by Dr. A. Braasch.—On petroleum springs, by S. B. Guttentag.—Ornithological notes on the fauna of the Lower Elbe, by F. Böckmann.—On the lepidoptera fauna of the same district, by L. Graeser and A. Sauber.

THE *Jahrbuch der kais. kön. geologischen Reichsanstalt zu Wien* (1879, part 1, January–March) contains the following papers:—On the metalliferous deep eruptions of Zinnwald-Altenberg (on the Saxon-Bohemian frontier), and on the tin-mining in that district, by E. Reger (with plates).—On the tertiary formation of Waldböckelheim (near Kreuznach, Rhenish Prussia) and its *polypterus* fauna, by Dr. A. von Klipstein.—On the geology of the Rhodope Mountain chain, south and south-east of Tatar Pazardžik, by Anton Pelz.—On the jurassic limestone rock *débris* in the diluvial formation of Moravia and Galicia, by Anton Rzehak.—Geological sketch of the highest part of the Sierra Nevada in Spain, by Dr. Richard von Drasche. This sketch is highly interesting and elaborate; it is accompanied by several plates and numerous illustrations.—On some limestones containing *orbicula* and nummulites from the so-called "Goldberg" near Kirchberg, on the Wechsel Mountain (Austria), by Franz Toulou.—Researches on the age of the North-Bohemian brown-coal (lignite) formation, by D. Stur.—On the productivity and the geotectonic conditions of the Caspian naphtha districts, by Hermann Abich.

THE *Moniteur Scientifique* (Paris: June, 1879), amongst numerous papers, which are noticed by us elsewhere, contains the following papers:—On the influence which a change of temperature exercises upon the deviation which inverted sugar produces upon polarised light, by Paul Casamajor.—On the acceleration in the tanning of hides by means of phosphoric acid, by E. Ador.—On "antichlore" (hyposulphite of soda), by M. G. Lunge.—On ozokerite and ceresine from Galicia, by Dr. J. Grabowsky.—Researches on the root of *Alstonia*, by O. Hesse.—On the use of anhydrous chloride of calcium as a conservative for steam-boilers, by M. Burstin.

THE *Journal of the Russian Physico-chemical Society* (vol. xi. No. 5) contains the following papers:—On the amines containing tertiary alcoholic radicals, by M. W. Rudneff.—On tertiary isosulphocyanates, by the same.—On the polarisation of electrodes, by M. A. Sokoloff.

THE *Rivista Scientifico Industriale* (Nos. 8 and 9, 1879).—From these numbers we note the following papers:—On a direct application of the free fall of bodies, by G. Mocenigo.—On the atmospheric whirlstorm of February 24–25, by Prof. L. Respighi.—On a telephonic microphone for demonstration at schools, by Prof. G. Cantoni.—On a new method to determine the specific gravity of liquids, by Prof. M. Cagnassi.—On some new phenomena connected with the plasticity of solids, by Prof. C. Marangoni.—On some phenomena due to the viscosity of liquids, by the same.—On sand showers, by Prof. Tacchini.—On a telephotographic apparatus with a single wire, by Prof. C. Perossino.—On the magnetic properties developed in nickel and cobalt by induction compared to those of iron, by Prof. T. Martini.—On a new steel-yard-densimeter, by Dr. C. Chistoni.

THE *Revue Internationale des Sciences* (May, 1879) contains the following papers:—On the glacial epoch, by Th. Kjerulf.—On the reciprocal assistance which descriptive and geographical zoology may render to each other, by M. Latase.—On the colouring-matter of urine, by M. Masson.—On the mechanical theory of the position of leaves, by Dr. Schwendener.—The number, besides the above, contains an interesting account of the organisation of medical instruction at Lyons, as well as an excellent review by M. C. Issaurat of Dr. F. Isnard's new book entitled "Spiritualisme et Matérialisme." This serial has considerably improved since it appears only in monthly parts instead of in weekly numbers as it did up to the beginning of 1879.

*Mittheilungen der naturforschenden Gesellschaft in Bern* (Nos. 923–936, 1877).—From this part we note the following papers of interest:—Botanical and geological notes from a tour in the province of Reggio in Calabria, by J. Coaz.—On the most important conditions of shape in the leaf of phanerogamic plants, by Herr Fankhauser.—On the principal laws of growth in *Floridæ*, by the same.—On the formation of the stem in *Lepas anatifera*, by Dr. Lang.—On some luminous bacteria, by Dr. M. Pertz.—Various notes on electrical instruments, by Herr Rothen.—On the soda efflorescences in the Ganges districts, by Prof. Schwarzenbach.—On the geology of Kerguelen's Land, by Prof. Th. Studer.—On deep-water siphonophora, by the same.—On the coloration of the retina, by Dr. A. Valentin.—On some preparations preventing fermentation, and their applicability for the conservation of food.

THE *Giornale di Scienze naturali ed economiche* (Palermo, 1878, vol. xiii.) contains the following papers:—On the cornea of osseous fishes; contribution to the morphology of the eye of vertebrates, by Dr. C. Emery.—On the solar spots observed at Palermo in 1877 and the first three months of 1878, and on the frequency of the vapours of iron and magnesium at the solar surface, by P. Tacchini.—Enumeration and synonyms of the conchyfera of the Mediterranean, by the Marchese di Monterosato.—On the fossils of the crystalline limestone of the Casale and Bellama Mountains in the province of Palermo, by Prof. G. G. Gemmellaro.

*Reale Istituto Lombardo di Scienze e Lettere, Rendiconti*, vol. xii. fasc. viii.—Mechanical demonstration of the second principle of thermodynamics, by S. Crotte.—On functions whose first derivatives belong to the class zero, by Prof. Ascoli.—Imaginary plane of linear complex and its intersections, by S. Aschieri.

Fasc. ix.—Prophylaxis of the plague, by Dr. Zucchi.—Researches on the electric conductivity of carbon, by Prof. Ferrini.—On the product of the more integrable and finite functions, by Prof. Ascoli.

## SOCIETIES AND ACADEMIES

### LONDON

Mathematical Society, June 12.—C. W. Merrifield, F.R.S., president, in the chair.—Mr. R. C. Rowe was proposed for election.—The following communications were made:—Notes on the reduction of a system of forces; and on plane curves, by Mr. J. J. Walker.—Notes on determinants of  $n$  dimensions, by Mr. Lloyd Tanner.—Curves for the inscription of a regular nonagon and undecagon in a circle, by the Rev. Dr. Freeth.—On Clifford's graphs and on the twenty-one co-ordinates of a conic in space, by Dr. Spottiswoode, F.R.S.—Two geometrical notes, by Prof. H. J. S. Smith, F.R.S.

Chemical Society, June 5.—Mr. Warren De La Rue, president, in the chair.—It was announced that a ballot for the election of Fellows would be held at the next meeting (June 19).—The following papers were read:—A contribution to the theory of fractional distillation, by T. E. Thorpe. The author has observed that of a mixture of equal volumes of carbon tetrachloride, boiling point  $76^{\circ}6$ , and of methyl alcohol, boiling-point  $65^{\circ}2$ ,  $46\frac{1}{2}$  per cent. of the whole distills over at  $55^{\circ}6$ – $55^{\circ}9$ ,  $10^{\circ}$  lower than the boiling point of its most volatile constituent.—Preliminary note on the action of organo-zinc compounds on quinones, by F. R. Japp. The author has studied the action of zinc ethyl on phenanthrene quinone and obtained a substance crystallising in faintly-yellowish plates having the composition  $C_{16}H_{14}O_2C_2H_5O$ ; he hopes by these reactions to distinguish quinones from double ketones.—Third report to the Chemical Society on researches on some points in chemical dynamics, by Dr. Wright, Messrs. Luff and Rennie. This is a lengthy paper in which the action of carbonic oxide and hydrogen on a uniform weight of copper oxide has been studied at various temperatures; the results are plotted out in numerous curves; in all cases carbonic oxide reduces more quickly or at a lower temperature than hydrogen.—On fractional distillation, by F. D. Brown. The author has studied with great care the distillation of mixtures of benzene and carbon disulphide.—On chlorstannic acid, by J. W. Mallet. A bottle containing a strong solution of stannous chloride after standing for a year deposited a transparent jelly-like substance which proved to be  $SnO_2 \cdot HCl$ . Soda and ammonia salts were obtained.—On indigopurpurin and indirubin, by E. Schunck.

Baeyer and Emmerling obtained a red-colouring matter from isatin, which they named indigopurpurin; this is identical with indirubin obtained by the author from indican. The author considers that the name indigopurpurin should be abolished.

**Physical Society, May 24.**—Prof. W. G. Adams in the chair.—New Members: Mr. Sedley Taylor, M.A., and Mr. Walter Emmott, A.S.T.E.—Mr. W. J. Wilson exhibited a new harmonograph and figures drawn by it. The figures drawn by prior harmonographs are all more or less imperfect owing to loss of motion in the pendulums actuating the marking pen; and Mr. Wilson therefore designed a new harmonograph which not only gives perfect figures but admits of the phase of either of the two compounded motions being decreased by a known amount. In this instrument toothed wheels take the place of pendulums, the ratio of the teeth giving the ratio of the periods of the motions. By employing the device of an intermediate wheel gearing with two others, and arranging two or more wheels on the intermediate axle, a great variety of phase can be obtained for each motion. An ingenious adjustment by means of a movable nut allows the phase of either or both motions to be altered to a known extent, and thus an endless variety of figures can be obtained. As in other harmonographs a writing-table on which the paper is placed, and an aniline glass pen, are used. Several of the figures done also on glass were thrown on the screen, the stereoscopic effect being very apparent. In reply to a query Mr. Wilson said that he had adapted some of the figures to the stereoscope.—Prof. Hughes explained his new induction balance and showed some of its principal effects. It is well known that on starting an electric current along a wire adjacent to another wire, an induced current is set up in the second wire in an opposite direction to the first or primary current. In the induction balance two primary circuits or coils are taken, with the same current (interrupted by a microphone acted upon by the ticking of a clock) running through both, and between these is placed a secondary circuit or coil in connection with a telephone. The primary coils are so wound as to oppose each other's induction on the intermediate secondary. There is a point, moreover, between these, where these opposed inductive influences exactly neutralise each other. If the secondary coil be placed there, no induced ticking of the clock can be heard; but if the secondary be displaced to one or other side of this point, the ticking can be heard in the telephone increasing in loudness as the secondary approaches one or other of the primaries. If the distance between the primaries be graduated into a scale, this contrivance becomes a sonometer, since it gives an absolute zero of sound, and degrees of loudness. It is well adapted for measuring the hearing power of the ear. By splitting the secondary coil into two parts and placing each close to its proper primary, so that there are four coils in all arranged in two pairs, the extremes in one primary circuit, and the means in one secondary, the two opposing parts of the balance can be separated from each other, so as not to disturb each other's action, and the balance made very sensitive by the closeness of the primaries and secondaries. Prof. Hughes finds that there is a line or zone of maximum induction midway between each primary and its secondary. If a conductor such as a piece of metal be put in this position it has a maximum disturbing effect on the balance, due probably to the electric currents generated in it by the induction. The effect is apparently proportional to the conductivity of the metal. It requires an exactly similar piece of metal put between the other pair of coils to restore the equilibrium of the balance. A difference of alloy, or of weight between two like coins is at once observed from the imperfect restitution of the balance; base coins are thus also at once detected. Again, it is possible for a person to tell what particular coin or coins are in one part of the balance by trial of the same coins in his part. When plates of non-magnetic metals are held vertical in the balance their disturbing effect is nil; iron on the other hand gives its maximum effect on this position, because its magnetic effect overbalances its electrical effect. Two pieces of iron may therefore neutralise each other as cores in an induction coil. Steel is easy to balance compared with soft iron. Zinc disturbs most when placed along the sides of each pair of coils; iron when in centre at a certain length of metal laid along the outsides of the coils produces silence. The maximum line of inductive force is midway between the coils, and there is a line of minimum force at half the thickness of each coil. A metal placed at these lines of minimum force has no disturbing effect on the balance. Pressure applied to small shot, or spongy gold, alters the balance. The effects of stress, heat, magnetism, light, &c., on matter could be determined

by the balance. Prof. W. G. Adams believed that one result of Prof. Hughes's experiments will be the determination of the way in which the law of electro-dynamic induction depends on density. He also imagined that the metal when in the maximum line between the coils gathered the lines of force to itself, whereas when on the minimum lines it could not thus divert them. Prof. Ayrton cited the early experiment of Faraday with a sheet of copper oscillating to rest between two opposite magnetic poles. The copper took a long time to stop; but a sheet of iron placed between two like poles was soon stopped owing to its becoming imbued with an opposite polarity, and deflecting the lines of force. He also suggested that the divergence of the results for conductivity of metals got by the induction balance from those got by the Wheatstone balance might be due to that electric inertia suspected by Sir William Thomson. Prof. Guthrie thought that the induction balance pointed to the conclusion that the disturbing effect of a conducting mass applied in this way is proportional to the quantity of electricity generated in it under certain conditions of temperature, &c. The determination of the conductivity of liquids would be a useful application of the balance. Mr. Chandler Roberts gave some results which he had obtained from an examination of certain alloys by means of the induction balance. He had been able to detect a difference of one part in 1,000 in the amount of silver in two shillings of equal weight. He also pointed out that Mathiessen divided alloys into three classes: (1) solidified solutions of one metal in another; (2) solidified solutions of one metal in an allotropic modification of another metal; (3) solidified solutions of allotropic modifications of both metals. For the first class the curve of electric conductivity is a straight line, for the second a parabolic curve, for the third a bent line. Mr. Roberts found that the balance gave the characteristic curve for the first class with an alloy of lead and tin, and for the second with an alloy of gold and silver. With a copper tin alloy, which is a good example of the third class, he found the curve given by the balance to be intermediate between Alfred Risch's curve of density and Mathiessen's curve of conductivity, and considers that the balance is influenced by the density as well as the conductivity of the metal interposed. Prof. Hughes said that as the working of metals appeared to affect their conductivity he was inclined to rely more on the conductivity measurements of the balance than on those of the Wheatstone bridge. By the balance plain pieces of metal were taken, whereas by the bridge wires were mostly taken. He would rather not give any theory yet as to the results obtained from the balance.—Dr. Erck then exhibited his novel pump for lifting solutions out of batteries. It consists of a closed vessel, funnel-like, the stem dipping into mercury, a column of which ascends the latter to a certain height. Two tubes emerge from the cover, one dipping into the liquid, the other opening to the air. By altering the pressure inside the vessel the solution rises to the latter, and can escape from it by trickling through the mercury.

**Anthropological Institute, June 18.**—Mr. Hyde Clarke, vice-president, in the chair.—The following new Member was announced: Mr. William Wavell, late of the Bengal Civil Service.—A paper was read by Miss A. W. Buckland on some Cornish and Irish prehistoric monuments. The authoress compared the sepulchral and the non-sepulchral monuments existing in the two countries, pointing out the differences between them, as indicating, either that they were erected by different tribes, or at various periods, and calling especial attention to the absence in Cornwall of the round towers, so common in Ireland, as well as of oghams, and those peculiar markings found in the Irish chambered tumuli at New Grange, Dowth, &c., as also in similar monuments in the north of Scotland and in Brittany. These markings are believed by Miss Buckland to represent the tribal or tattoo marks of the Picts or a kindred race, being one of many different tribes brought by tradition from the neighbourhood of the Euxine, a tradition apparently confirmed by the decidedly eastern characters of the jewellery found in Ireland, as well as by the megalithic monuments which can almost all be traced to Eastern Europe, and thence through Western Asia to India. Notwithstanding this apparently common origin, Miss Buckland pointed out that they are almost everywhere arranged in groups suggestive of a difference of race in their constructors, and expressed a hope that some day a map of the world would be constructed showing these groupings, which would be a great help to students of ethnology and archaeology.—Mr. C. Pfund also read a paper entitled "Some Facts about Japan and its People," and exhibited drawings in illustration of the same.

**Entomological Society, June 4.**—H. W. Bates, F.L.S., F.Z.S., vice-president, in the chair.—The following elections took place:—Mr. J. Walhouse, F.R.A.S., Maida Vale, as an Ordinary Member, Señor Antonio Augusto de Carvatho Monteiro, Lisbon, as a Foreign Member, and Mr. C. H. Goodman, Lesness Heath, as a Subscriber.—Mr. McLachlan called attention to a notice lately published by M. F. A. Forel, concerning certain sculptured markings on cretaceous pebbles from the shores of Lake Lemán, in which the author has come to the conclusion that the markings were mainly due to the action of larvæ of trichoptera, which formed galleries on the surface. Mr. McLachlan exhibited plaster casts of two small blocks, one of Jurassic limestone, the other of ordinary white chalk which had been placed in the lake by M. Forel for some months, and which showed markings that apparently confirmed the theory that such were due to the agency of trichopterous larvæ, of which some specimens in alcohol were also exhibited.—Mr. J. S. Baly communicated a paper entitled "An attempt to point out the differential characters of some closely allied species of *Chrysomelæ*, chiefly those contained in Suffrian's 11th group; also descriptions of some hitherto uncharacterised forms belonging to the same and other genera of the family."—The following papers were communicated by Prof. Westwood:—"A decade of new Cetoniidæ," and "On some unusual monstrous insects."—Mr. W. L. Distant read a paper entitled "Contributions to our knowledge of the hemipterous fauna of Madagascar."—Sir Sydney Saunders communicated some notes received from M. Jules Lichtenstein, describing the metamorphoses of the blister-beetle *Cantharis versicatoria*, which he had recently succeeded in rearing from the egg.—Mr. Meldola communicated a translation of a paper by Dr. Fritz Müller, recently published in *Kosmos*, entitled "Ituna and Thyridia; a Remarkable Case of Mimicry in Butterflies."

**Victoria (Philosophical) Institute, June 16.**—The president, the Earl of Shaftesbury, in the chair.—Capt. F. Petrie (the Honorary Secretary) read the report. It appeared that the Society had lost twenty by death, and twelve members and eighteen associates by resignation, since the last annual meeting, but that eighty-six new members had joined in that time. The total number of members is now 785. The address was delivered by Dr. Radcliffe, and took the form of an inquiry into the present position of physical science.

#### EDINBURGH

**Royal Society, June 16.**—Prof. MacLagan, vice-president, in the chair.—The following communications were read:—Atomicity or valence of elementary atoms: is it constant or variable? by Prof. Crum Brown.—On the action of heat on salts of primethyl-sulphine, part iv., by Prof. Crum Brown and J. Adrian Blaikie, D.Sc.—Comparison of the salts of methyl-diethyl-sulphine, and of ethyl-methyl-ethyl-sulphine, by Prof. Crum Brown and J. Adrian Blaikie, D.Sc.—On the bursting of fire-arms when the muzzle is closed by snow, earth, grass, &c., by Prof. George Forbes.—On some new bases of the leucoline series, part iii., by G. Carr Robinson and W. L. Goodwin.

#### BOSTON (U.S.A.)

**American Academy of Arts and Sciences, May 14.**—Hon. Charles Francis Adams in the chair.—Dr. H. P. Bowditch presented a new form of plethysmograph differing from those of Mosso and von Basch in the method adopted for securing a constant level of the fluid in the receptacle connected with the apparatus which contained the body whose changing volume was to be measured. The method consisted in suspending the receptacle (a large sized test tube) to a delicate spiral steel spring of which the length and strength were so adjusted that the weight of the fluid flowing into the test tube caused an elongation of the spring precisely equal to the rise of the fluid in the test tube itself. Thus the absolute level of the fluid in the receptacle remained unaltered, and a constant pressure was maintained upon the surface of the organ to be measured. An index attached to the lower end of the spring recorded upon a revolving cylinder covered with smoked paper the flow of the fluid into and out of the receptacle.—Mr. N. D. C. Hodges gave two new proofs of the dimensions of molecules, one based upon the properties of water and aqueous vapour, the other upon superficial tension and considerations of the depth of the superficial layer of molecules upon sheets of platinum.—Prof. Pickering exhibited a new form of photometer for measuring the light of a nebula or comet, by comparison with a star thrown out of focus. The method employed eliminated the effects of moonlight or twilight. He also proposed to denote

the light of these bodies in stellar magnitudes. Thus a portion of a nebula would be of the twelfth magnitude, if of the same brightness as a twelfth-magnitude star spread over a circle one minute in diameter.—Prof. John Trowbridge presented two contributions from the Physical Laboratory of Harvard College, one on the vibration of elliptical plates, and one on a new method of studying wave-motion and vibrations on the surface of mercury. The mercury is covered with a very thin film of lycopodium dust, and is illuminated by the electric spark produced by breaking a circuit on the surface of the mercury.—Prof. C. Loring Jackson and Mr. J. Fleming White announced a new synthesis of anthracene.—Prof. Asa Gray presented the characters of new species of plants from Mexico, collected by Dr. E. Palmer and Dr. C. C. Parry.—Prof. Wolcott Gibbs, a research on complex inorganic acids; and Mr. Sereno Watson, a revision of the North American liliaceæ and descriptions of some new species of other orders.

#### PARIS

**Academy of Sciences, June 9.**—M. Daubrée, president.—The following papers were read:—Chronometric observatories for the merchant marine, by M. Faye.—On the spherical regulating spiral of chronometers, by M. Phillips.—On the bases derived from aldehyde-ammonia, by M. Ad. Wurtz.—Determination of the height of the mercury in the barometer under the equator; amplitude of diurnal barometric variations at various stations in the Cordilleras, by M. Boussingault.—Increase of albumenoid matters in the saliva of those having albumenuria, by M. Vulpian.—On the spectrum of nitrate of didymium, by MM. Laurence Smith and Lecoq de Boisbaudran.—On the spectrum of nitrate of erbium, by M. Lecoq de Boisbaudran.—Observations made during the voyage of the frigate *La Magicienne*, by Admiral Serres.—The following papers were among the correspondence:—Observations of Comet II., 1867, made at the Observatory of Florence (Arcetri), by M. Tempel.—Transformation of a pencil of normals, by M. A. Mannheim.—On the use of elliptic functions in the theory of the plane quadrilateral, by M. G. Darboux.—On developments in series whose terms are Laplace's functions  $Y_n$ , by M. A. de St. Germain.—On the laws of dispersion, by M. Mouton.—On Stokes's law, by M. S. Lamansky.—On the absorption spectra of alizarin and some colouring-matters derived from it, by M. A. Rosenthal.—On the *verglas* of January 22, by M. de Tastes.—On the dissociation of ammonium sulphide, by MM. R. Engel and Mortessier.—Action of the vapour of water on carbonic oxide in presence of a red hot platinum wire, by M. J. Coquillion.—On some derivatives of methyleugenol, by M. Wassermann.—On an isomer of angelic acid, dimethyl-acrylic acid, by M. E. Duvalier.—On the action of phenate of sodium in bacteriemic frogs, by M. Bacchi.—Hematic lesions in chlorosis, the serious anemia named progressive, and the anemia of nephritis, by M. Quinquand.—Researches on the localisation of arsenic in the brain, by MM. O. Caillol de Poncey and Ch. Livon.—Rectification in a communication of March 17 last, by M. Feltz.—Erratic blocks of the Valley of Lys (Haute-Garonne), by M. Gourdon.—Fall of meteorites on May 10, 1879, in Emmet County, Iowa, U.S., by Prof. Hinrichs.

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